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ABSTRACT

Outlined are practices and procedures that should be followed in order to protect and fully realize the benefits of sewer systems and also to maximize service and minimize inconveniences to the public. Written in practical terms, the manual is designed to be of immediate use to municipal employees and others involved in sewer maintenance operations. Topics covered are (1) operation and maintenance, (2) industrial waste problems, (3) safety, (4) preventive maintenance, and (5) sewer by-laws. (WB)

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FOREWORD

This manual is the successor to the Sewer Maintenance Manual dated July, 1964 as prepared jointly by the City Engineers Association and the Ontario Water Resources Commission. The former Manual was extensively used but advancing technology and the rapid spread of sewer systems (especially in smaller municipalities) throughout the Province in the ensuing decade led to a decision by the MEA/MOE Liaison Committee to set up a Sub-Committee to investigate updating the 1964 Manual. This Sub-Committee which consisted of H. G. Payne, P. Eng., Commissioner of Works, City of Windsor, J. M. Skinner, P. Eng., Senior Maintenance Engineer, Borough of North York and R. E. Brown, P. Eng., Operations Engineer, Project Operations Branch, Ontario Ministry of the Environment initially confirmed that an updated manual was necessary and desirable and proceeded to establish the following guidelines:

1) The Manual would be written in practical terms so as to be of maximum use to those actually carrying out sewer maintenance work

2) The Manual would not attempt to completely cover the wide diversity of all the sewer maintenance practices in use in Ontario but would provide a reasonably detailed guide which could be expanded or modified to suit conditions in one particular area.

3) The Manual would be intended for both municipal staffs and forces employed directly by the Ministry of the Environment in sewer maintenance operations.

It is considered that the practices and procedures outlined herein should be followed in order to protect and fully realize the benefits of the vast investment in sewer systems and also to maximize service and minimize inconvenience to the public.

Comments or questions on the contents of the Manual will be welcome and should be directed to any member of the Sub-Committee.

H. G. Payne, P. Eng.
March 1974

operation and maintenance of sewer systems

SEWER MAINTENANCE MANUAL

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Operation and Maintenance of Sewer Systems

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OPERATION AND MAINTENANCE OF SEWER SYSTEMS

During the past few years a much greater awareness has developed with respect to ecological conditions that exist in the areas surrounding large population and industrial centres. This awareness on the part of the general public has caused many changes in the methods and procedure for the handling of the various types of wastes that the modern way of life has produced. One of the greatest problems in the area of waste control is the handling of water borne wastes both domestic and industrial.

Not so many years ago most centres simply dumped their sewage into the nearest body of water that was large enough to carry it. As populations increased and industries expanded many rivers became nothing more than open sewers while lakes and bays became cesspools. As the problem grew the need for proper sewerage systems and sewage disposal became evident. However, the installation of an adequate sewage disposal system, in itself, is not the complete solution to the problem, once the system is installed it must be maintained to ensure it operates in the way its designers intended.

The ease with which a system is maintained depends firstly on how well it was designed and secondly on how it was constructed. A system that is designed with too little slope will allow the solids to settle out, thus causing build ups of material in the pipes which in turn cause sewage back ups. In order to prevent basement floodings these sewers must be cleaned much more regularly than those with sufficient slope to ensure proper scouring. When care is not taken in the installation of sewers many problems can develop. Open joints and improperly installed laterals allow ground water and root infiltration, poor bedding practices will allow dips to develop which

in turn slow the flow to the extend that solid build ups occur.

In order to ensure proper design of a system it is necessary to have a good set of design standards and specifications and in order to ensure proper construction of the system a comprehensive inspection program should be established. Inspectors should be on the job at all times when pipe is being laid checking grades, bedding, joints and lateral connections. Before any sewer is accepted for use it should be thoroughly cleaned and a final inspection made, preferably oy one of the photographic methods described in a later section.

SEWER USE BY-LAWS

Sewer use bylaws will be dealt with in greater detail in a later section, however, as these bylaws are usually enforced by the maintenance and operating department of a municipality, and how well they are enforced will be a factor in the maintenance of a system, they should be mentioned at this point.

Sewer use bylaws deal with what can be discharged into the municipal sewer system and how it can be discharged.

What can be discharged into a sewer is of great importance, effluents with a high biochemical oxygen demand would require special treatment at the disposal plant, those with a high heavy metal content could disrupt the process of the disposal plant. Effluents with a high suspended solid count could cause a build up of solids in the line and low PH factors could cause the erosion of a sewer.

Industrial effluents must be tested from time to time to ascertain if they are within the limits prescribed by the bylaw. In order to facilitate this testing it is necessary to have manholes installed on the sewer connection adjacent to the street line. These manholes should be built and maintained by the industry involved.

If the effluent is found to be outside the limit of the bylaw it

would then be necessary for the industry to install pre treatment facilities in order to bring the discharge within the limits.

SEWER INSPECTIONS AND CLEANING

All sewers should be inspected on a regular basis. These inspections should note the amount of flow in the sewer, the velocity, any build up of solids, grease, etc., the condition of the pipe and appurtenances.

Sewers are usually inspected or cleaned by one or more of the following methods:

Visual
Mechanical
Photographic

VISUAL INSPECTION

As the name implies visual inspection is simply opening a manhole, entering it (refer to paragraph in section on safety on the proper precautions to be taken before entering a manhole) and visually checking everything about it. The brickwork should be checked for loose bricks, which might fall into the manhole and cause a blockage. The ladder should be inspected for corrosion etc. which might weaken a rung, and the general condition of the concrete should be noted. The depth and velocity of the flow should be noted and how it compares with the depth and velocity of the flow in the upstream manholes. If there is less depth and more velocity in the downstream manhole it could indicate a partial blockage in the line. The condition of the walls and crown of the pipe should be checked, if the diameter of the pipe is such that it will not allow direct visual inspection this can be carried out by using mirrors. A mirror is placed in the upstream manhole and a light in the downstream one, the condition of the pipe can be checked in the mirror. This method is rather limited with respect

to faults that are any distance from the manhole. In recent years some sewer systems have been designed with horizontal curvature between manholes and this of course would preclude this type of inspection.

MECHANICAL INSPECTION AND SEWER CLEANING

Mechanical inspections and sewer cleaning can be done in a number of ways such as: fire hose flushing, an inflated rubber ball, power rodders, bucket machines and sewer jet flushers.

Fire Hose Flushing

The flushing of sewers can be of value under certain circumstances, in areas of low flow such as dead ends etc. there often is a build up of solids due to an insufficient amount of water and too slow a velocity to keep these solids in suspension. Flushing increases both the quantity and the velocity in the line so that the necessary scouring action can take place.

Where partial blockages exist fire hoses discharging into a manhole can cause heads to build up in the manhole, the pressure generated by these heads is often sufficient to dislodge these blockages. Care must be exercised to ensure that during periods of flushing heads are not built up to a height greater than the difference in elevation between the sewer invert and the basement floors in the area to prevent basement flooding.

There are fittings that can be placed on the end of fire hoses such as rotating nozzles, rotating cutters, etc. when these are dragged through the sewer they can be effective in removing light material from the walls.

Fire hose flushing is the least expensive method of cleaning sewers, however, it also is the least efficient as it is difficult to remove dislodged material from the line.

Inflated Rubber Balls

Inflated rubber balls have had a wide acceptance in sewer cleaning, they are easy to use and inexpensive. As the name suggests this is a ball constructed of heavy rubber which is inflated to a diameter slightly less than that of the sewer to be cleaned. When the ball is placed in the pipe the effluent in the sewer cannot pass it and a head is built up in the manhole the pressure in the manhole builds up to a point where it is greater than that in front of the ball and it starts moving downstream. A drag line is attached to the ball so that it may be removed if a problem arises. As the ball moves it takes up the configuration of the pipe and as it is slightly smaller than the pipe some of the water behind it passes by causing jets to shoot out in front removing a considerable amount of debris from the pipe walls.

As in the case of flushing care must be exercised to ensure the head built up does not get to the point where it will cause basement flooding and there is difficulty in removing dislodged material from the sewers.

The cost of this type of cleaning is greater than flushing but still less than most other methods and a higher production rate can be realized than with any other method of cleaning.

Power Rodders

Power rodders come in a variety of sizes and mountings but essentially the principle of all rodding machines is the same, that is a continuous rod of 3/8 or 1/2 inch diameter and from 1000 to 2000 feet in length being pushed through the sewer by mechanical means. This rod is usually stored on a large reel and fed through a mechanism that controls its forward ard backward movement. The rod can be either continuous - a continuous spring steel rod with no joins in it - or a sectional rod - made up of a number of short rods joined together by

couplers. How the rod is propelled through the sewer depends on the type of rod being used.

The continuous rod is controlled by a number of rollers approximately twelve inches in circumference, these rollers are grooved in order to grip the rod and move it either forward or back at speeds up to 150 feet per minute. These rollers reverse instantaneously at full power so that the rod can be moved backwards and forwards whenever the going is difficult.

The sectional rodder has a continuous chain drive, there are a number of lugs on this chain spaced the same distance apart as the couplers on the rod, as the chain rotates the lugs engage the couplers and pull the rod off the reel.

The reel on which the rod is stored will rotate in both a clockwise and counter clockwise direction thus the rod can be moved forward and backward while rotating to transmit greater cutting power to the head enabling it to pass through just about any blockage in the pipe.

There are a number of attachments which can be used with the rodder depending on what type of material is to be removed from the line. Some of these attachments are:

Round Stock Corkscrew - as the name implies this tool is in the shape of a corkscrew and is normally used when an unknown condition exists in the sewer.

Square Stock Corkscrew - same as above except it is made from a square stock, the trailing edge of this unit is sharpened and it is used to remove heavy root build ups while being pulled back through the sewer.

Auger - this attachment is made of a flat stock with both sides sharpened and is used to remove roots and loosening sedimentary deposits in the bottom of the pipe.

Root Saw - this is also made from a flat stock with saw tooth edges front and back.

Spring Blade Root Cutter - this is made of three straps of spring steel sharpened on both sides these straps splayed out from the centre and press against the wall of the sewer as the unit is pulled back through the sewer ir rotates cutting roots as it goes.

Porcupine - this is cylindrical in shape with a number of pieces of heavy wire rope radiating from it. This is used for cleaning sediment from the walls of the sewer.

These attachments are usually connected to the end of the rod and then pulled backward through the sewer - some like the corkscrew and auger can be used in both directions and are usually used in investigating blockage.

Rodders are ideal for checking sewers for blockages and removing them from the line. It is mobile - whether truck or trailer mounted - so that it is easily moved from place to place. It is easy to set up and to operate, therefore, it is useful in cases of emergency.

Although a power rodder will normally locate and break through the great majority of blockages and thus relieve flooding, it cannot be used to clean sewers, for this you should use bucket machines or jet sewer flushers. It will not find a great number of sewer faults nor would it indicate what the nature of the fault is.

If a comprehensive sewer cleaning program is to be set up and bucket machines are going to be used as the main cleaning equipment then a power rodder is mandatory as the fastest and surest way of inserting the bucket cables in the sewer.

Bucket Machines

The bucket machine is probably the most common type of sewer clean-

ing equipment in use today. It was the first production type equipment on the market and took sewer cleaning out of the "wait till something happens" era and brought it into the preventative maintenance field.

The machines themselves consist of a winch drum capable of holding 1000 feet of 1/2 inch wire cable, powered by a gasoline engine of from 9 to 35 horsepower. There is a clutch and transmission assembly so that the drum can revolve in a forward or reverse direction or run free.

The bucket is an elongated bucket with a clam shell type bottom which opens to allow the material removed from the sewer to be emptied. These buckets can be obtained in various sizes capable of cleaning sewers with diameters ranging from 6 to 36 inches.

The machines are trailer mounted usually with three wheels and are towed in tandem from site to site. This makes them much less mobile than power rodders and, therefore, not readily adaptable to emergency work.

When an area is to be cleaned two machines are used. These machines are set up over two adjacent manholes and the 1/2 inch wire cable from one machine is pulled through the section by means of a line which is placed in the sewer prior to the arrival of the machines. The bucket is secured to the cables from each machine and then is pulled back and forth through the section until the sewer is clean. Sewers are usually cleaned with the bucket travelling in the direction of the flow and every time the bucket comes to the downstream manhole it is brought to the surface and emptied.

The line which is originally placed in the sewer and used to pull the 1/2 inch cable through can be placed there by floating a light nylon line through the section and then pulling the cable through with the light line. This method is slow and it is very difficult to float a line through a pipe that has even a slight blockage in it, therefore, it is not recommended where a number of sewers are to be cleaned.

Pre cabling of sewers is done much more efficiently by power rodders and one rodder can service a number of bucket machines. Pre cabling should be carried out the day before the actual cleaning is to take place and these cables should not be left in a sewer for more than forty-eight hours as they will sometimes pick up materials floating through the sewer and cause blockages.

Bucket machines can cause damage to sewers if they are not used properly or if there are faults in the line they could make them worse, for example a protruding lateral could be broken off in such a way as to open up a hole in the pipe thus allowing infiltration. If there are any restrictions in a pipe such as calcium buildups at joins the bucket will not pass through, however, this problem can be overcome by using a bucket with a smaller diameter.

There are a number of attachments that can be used with these machines to ensure that all extraneous material is removed from the sewer such as grease, calcium, tree roots, etc. because of this the bucket machine should be a part of all sewer maintenance departments.

Sewer Jet Flushers

The sewer jet flusher is the newest of the sewer cleaning machines but because of its versatility it is quickly gaining in popularity. Not only can it be used for cleaning sewers, it can also be used for spraying trees and boulevards, cleaning signs, etc. and even in some cases for cleaning roads.

The machine itself is usually truck mounted and consists of a large watertank of at least 1000 gallons, a triple action water pump, capable of producing 1000 p.s.i. or more, a gasoline motor to run the pump, a hose reel large enough for 500 feet of 1 inch inside diameter high pressure hose and a hydraulic pump to operate the hose reel. Even though the hose reel can carry 500 feet of hose most units will only

carry 400 feet with an additional 100 feet available in case it is required. The reason being that most manholes on sanitary systems are less than 400 feet apart and every extra foot of hose being used reduces the nozzle pressure. In order to clean sewers properly a minimum nozzle pressure of 600 p.s.i. is required.

In cleaning sewers various types of nozzles are used depending on the size of the sewer and what problems are inherent in the sewer. All nozzles send a fine spray backwards at such an angle as to cover the entire circumference of the pipe. The hose is propelled through the pipe by the action of the jet and then is brought back by the drum. The main cleaning of the pipe is done on the return of the hose and all material in the sewer is flushed ahead of the nozzle to the manhole. Care must be exercised when cleaning sewers with large accumulations of dirt or grease to ensure that this material does not pass through the manhole and into the next section thus causing blockages further downstream. This can be done simply by placing a sand bag in the invert of the outlet pipe allowing the water to pond in the manhole, the solids settle out and the water runs over top of the sand bag and out of the sewer. If sand bagging does not give sufficient sanding a 90° pipe elbow with an outside diameter the same as the inside diameter of the pipe can be used. The height of the upright leg of the elbow would have to be such as it prevents basement flooding in the upstream portion of the sewer.

This type of machine is, like the rodding machine, extremely mobile, will clear just about any blockages, and is easy to set up, therefore, it is an ideal unit for emergency work.

About the only problem the machine will not cope with is roots.

The above are the most commonly used sewer cleaning machines. Each can be used independently of the other, however, none of them is a

panacea of sewer problems and any comprehensive sewer cleaning programs should include all those machines.

The acquisition of all machines might not be economically possible for communities that have small systems. However, in the past few years a number of contracting companies have been set up who will inspect, clean and in some cases repair sewers. These companies can be used in conjunction with municipally owned equipment or they will set up a complete maintenance program for a community.

PHOTOGRAPHIC INSPECTION

Complete inspections of sewers that gave definitive answers as to the condition of a sewer were impossible up until just a few years ago when a camera casing was designed to allow cameras to be dragged through a line and take a series of still photographs. This method was later expanded to continuous moving pictures and also closed circuit television. It is now possible with these innovations to find exact faults and their locations and this of course has been a great boon to sewer maintenance personnel.

The camera casing involved in sewer photography is bullet shaped, about six inches in diameter and made of stainless steel. There is a face plate on the flat end which houses the camera and the lights. The power cables are attached to the sharp end through water tight couplings. The casing is attached to two skids by four legs which can be extended or shortened depending on the size of sewer to be photographed. The camera is pulled through the sewer with a hand winch or power rodder depending on the type of photography used normally in the direction of the flow.

Color Still Photography

In this method the camera would be dragged through the sewer by a

hand winch. It is stopped at predetermined intervals - 3 feet - 6 feet, etc. and the camera triggered electronically. The distance between photographs is very important in this type of photography as the greater the distance the more chance there is of missing some defect in the line. As each picture is taken the distance from the manhole is recorded and when the film is developed it is then possible to locate problems.

Coloured Motion Pictures

In this method the camera is dragged through the sewer by a power rodder as a constant speed is required. Each section of sewer is completely photographed on one reel of film and after developing can be reviewed any number of times. Faults in the pipe can be determined and the location calculated either by the time required to get to the point of the fault or by counting pipe lengths; some cameras are equipped with footage counters but these are often inaccurate and interfere with the viewing.

Some of the problems involved in this type of photography is that you cannot tell if there has been a malfunction of the camera until after the film is developed. If there is a blockage in the pipe or the camera gets stuck it will run out of film before the end of line is reached.

The advantage is that you have a permanent record of the entire length of the sewer which can be reviewed at any time.

After several sewers have been photographed in this way a number of films are accumulated. Each one should be numbered, noting the year taken and the film number, then a cross-reference sheet should be completed showing the corresponding sheet for each number.

Closed Circuit Television

In this method the camera is dragged by a hand winch as speed is not important and there is a great deal of stopping and starting. As the camera progresses through the sewer it is viewed on a monitor usually set up in the operations vehicle. When a fault is found the camera is stopped, the distance from the manhole ascertained, and a stillphotograph is taken of the fault. Still photographs can be taken in two ways either by taking a picture of the monitor which gives a black and white picture that is not always as clear as desirable or by mounting a still camera in the casing along side the T.V. camera and triggering it electronically as is done in the colour still picture method. This is a superior way as it usually produces a clearer coloured picture of the fault.

The advantage of this method is that there is no limit on the time the camera is in the sewer as there is no possibility of running out of film. The viewing of the sewer and location of faults is most accurate and immediate and therefore, excellent in cases of emergency.

The disadvantages are that if you wish first hand viewing of the sewer - and this is necessary on a number of occasions - you must be present at all times when viewing is taking place. If at a later date you wish to check something in the line that was not photographed the first time a second must be made.

All methods of photography are dependent on the condition of the sewer. If the sewer is dirty or grease encrusted serious faults could be covered up and missed. Therefore, all sewers should be carefully cleaned before photographing. If there is a high water level in a sewer the camera would be under water a great deal of the time if this is a possibility then the flow should at least be partially blocked off before the camera starts through the line. This can be done by

placing a sand bag or some other method of pipe blocking in the first manhole upstream from where the operation is taking place. Care must be exercised to make sure these blockages can be quickly removed in case surcharging occurs upstream.

CROSS CONNECTIONS

It is possible where there are separate sewer systems for the storm and sanitary connections to be crossed. That is for the sanitary connection to go to the storm sewer and the storm connection to go to the sanitary sewer. When this exists serious pollution problems materialize at storm outfalls, and basement flooding can result during heavy rains due to the overloading of sanitary sewers.

Storm outfalls should be checked at least once a year and when any signs of pollution are observed then checking should be commenced to locate the source.

A water sample should be obtained from the outfall and analyzed for coliform count, B.O.D. suspended solids, phenols and any other material that might indicate possible sources. Sampling should be extended up stream to a point where the pollution is no longer in evidence, when this is located then every premises in the area between the last manhole where pollution was evident and the first manhole where it was not, should be tested until the offender is found.

If sanitary sewage appears at the outfall a simple method of checking upstream is to place screens in the outlets of manholes. These screens will catch any solids that are in the water. When solids appear on one screen and the next screen upstream is clear every premises between the two manholes should be checked. Once the offending connection is found then the whole building should be checked to ascertain whether the problem is a crossed connection or merely one fixtur

that has been improperly installed. When the cause of pollution has been corrected then the whole system should be checked again to ensure that no other problems exist.

DYE TESTING

Once the general area of pollution is found then each premise must be checked in order to find the offending connection. One method of checking is dye testing. To do this fluorecein dye is put in the connection either through a cleanout or a fixture and then both sanitary and storm sewers are watched until the dye appears. In each premise every unit discharging into a sewer should be checked as there are many cases where individual fixtures can be connected to the wrong sewer.

Dye testing is a relatively slow method of checking what is discharging into a sewer especially when a number of units must be checked. Every time dye is placed in one unit you must wait until the dye is completely dispersed before checking the next one, if you do not then the dye becomes one large mass when it reaches the sewer and even if one test goes to the wrong sewer it is impossible to tell which is the offending unit. One way of speeding up the process is to use different coloured dyes alternating them with every test then if an accurate record is kept of what was placed in each unit a positive result can be achieved.

The dyes used in this type of testing can be either in powder form or liquid whichever is the most convenient for that particular job. As stated above various colours of dyes are available but those used most frequently are red and green. Care must be taken when using dye not to spill it on floors and walls as it is very difficult to remove.

SMOKE TESTING

Smoke testing is a much simpler and faster method of checking for cross connections, however, the results may not always be as positive.

To carry out a smoke test you need a number of smoke bomos of three or five minute duration and a blower fan that can be placed over the manholes. A bomb is dropped into a manhole and then the fan is placed over it. The fan forces the smoke through the sewer and into any connection that may be connected to it. The smoke then enters the plumbing system that the connection services and emerges through roof vents eavestroughs and catch basins, etc. When the smoke emerges then it is simply a matter of determining whether that fixture through which the smoke is emerging should be connected to the sewer being tested.

If a plumbing system is trapped then the smoke will not enter it, therefore, some knowledge of the plumbing system in the area being tested is required and any areas that are trapped should be checked by dye testing.

Because the smoke used in this test takes only a very short period of time to fill a sewer section large areas can be covered in much shorter periods of time than dye testing and where smoke does appear the results are positive.

INFILTRATION

Infiltration is the intrusion of material into a sewer that should not be in it and the main items of infiltration are ground water and tree roots. Most sewers are designed to accept a certain amount of ground water but if this becomes excessive then an overloading of the sewers could result which might cause serious flooding problems. Ground water infiltration is common in areas of high water table which could result from old water courses being filled in to provide larger areas for construction.

Ground water will enter a sewer through cracks in the pipe poorly installed house connections and open joints. Tree roots can enter through the same type of openings and when heavy tree root infiltration

exists then there is a considerable lessening of the sewers capacity. Root infiltration usually takes place in areas where large numbers of willow, poplar, and soft maple trees exist and small amounts of roots entering a sewer can expand when inside to such a degree as to completely fill the inside of the pipe. Root infiltration can be controlled to a degree by cutting them out of the line by one of the attachments for the power rodders or bucket machines as described earlier or by repairing the area of the pipe in which the infiltration occurs. This can be done by exposing each offending joint, and repairing it but this is a slow and costly procedure. The more efficient methods are by grouting the joints or relining the whole pipe with a plastic liner.

Grouting of Joints

When infiltration exists in a relatively few joints in a sewer the most economical method of repair is grouting. In this method the offending joints are located by closed circuit television as described earlier. When these are located the grouting equipment is put in place using television cameras to ensure it is in the proper location.

This equipment consists of a large tube shaped unit with an inflatable rubber tube at each end. When the unit is located over the joint to be repaired the rubber tubes are inflated so that there is a watertight seal at both ends and only a small opening between the tube and the pipe. The tube is connected to the surface by two hoses one for the air to inflate the tubes and one for the grouting material. When the tube is in place the grout which is a plastic material is forced through the grout hose by compressed air and into the opening between the tube and the pipe. As there is considerable pressure exerted on the grout by the compressed air

it is forced around the outside of the tuoe and into the opening of the joint. A considerable amourt of this material is forced through the joint so that the outside of the pipe is completely surrounded by it to the extent that neither roots nor water can enter the pipe. When the grout is set the air is released in the inflataole tubes and unit moved to the next joint to be repaired.

Relining of Sewers With Plastic Pipes

When root and water infiltration is extensive than an alternative method of repair is the relining of the sewer with a plastic pipe.

In this method the first operation is to ensure that the pipe to be repaired is absolutely clean. This is done by sending an air operated reamer through it, this reamer removes everything from the sewer including grease, calcium ouildups, tree roots, protruding house connections etc. When this operation is completed a short length of the sewer is exposed and the sewer opened to allow the plastic pipe to enter.

When everything is ready for the pipe then short lengths of pipe whose outside diameters are slightly smaller than the inside diameter of the pipe oeing lined, are brought to the excavation and laid end to end. These pipes are then thermally buttwelded so they form one long length. The end of the plastic pipe is then placed in the sewer and the pipe threaded through it by means of a vibrating unit. When the pipe is in place the space oetween the original pipe and the liner is filled by a cement grout forced into the space by high pressure pumps.

When the liner is in place and the grout is set all connections are completely sealed off and have to be opened. In order to do this each connection must be exposed and opened. A cutter is then

placed in the connection and the portion of grout and liner which cover the end of it is cut out.

When the operation is completed the relined sewer is smaller than the original, however, its carrying capacity is often increased as the plastic pipe is smoother than that of the original.

EXFILTRATION

Where infiltration exists then exfiltration could also exist on the lowering of the water table. This is the leaking of water out of a sewer. If there is a great amount of water leaking out of a pipe the earth around it is washed away and when the void becomes large enough sewer and road collapse occurs.

SEWER GAUGES

How well a sewer functions after it is constructed depends on how well it was designed. How well a sewer is designed depends on the design criteria in use by the municipality. Design criteria can be checked by measuring the flow in a sewer over a long period of time and comparing the flow to that derived from the criteria. This can be done by sewer gauges equipped with permanent recording devices.

Basically there are two types of sewer gauges:

The Pressure Measuring Type

The Probe Type

The Pressure Measuring Type

This type consists of a compressed air cylinder which is converted by a 1/4 inch pipe to a control unit in a recording instrument. The instrument is connected by a 1/4 inch impulse pipe to a dip tube immersed in the liquid. The air from the cylinder flows into the impulse pipe and continuously bubbles out of the end

of the dip tube. The Pressure developed in the dip tube and to the connection to the instrument is equivalent to the head of liquid on the dip tube. As the head varies so the pressure to the instrument varies and this information is recorded on a chart in terms of liquid level.

The instrument is portable and can be moved with relative ease although it requires a compressed air cylinder. It has a permanent recording and that records up to six weeks on one chart. It will record surcharges up to the maximum range of the chart.

The Probe Type

This unit is much simpler than the pressure type in that it is very compact and does not require air cylinders. The recording unit is mounted in a bracket near the top of the manhole. A thin metal probe is then lowered on a wire controlled by a small motor in the recording unit. When the probe touches the surface of the water a micro ampere circuit is made through the conductive liquid to a ground return. This current causes the motor to reverse and raise the probe above the surface breaking the circuit and again reversing the motor. This action continues with the probe maintaining a position slightly above the surface.

The changes in height of the probe are transferred to a chart in the recording unit. This chart is spring powered and can operate in either a twenty four hour or seven day cycle.

This unit is easier to install than the pressure type. It also has permanent recording charts and will record surcharges up to the maximum range of the chart.

PUMPING STATIONS

It is sometimes necessary to lift sewage from a low area to a higher one, this is accomplished by sewage pumping stations.

Pumping stations are a major problem in any sewerage system in that a failure in one can cause serious pollution and flooding problems and failures can occur for many reasons such as power shut down, machinery break down clogging of inlet and outlet pipes, etc.

Stations should be checked daily, all grates should be cleaned, the pumps checked to ensure they are operating properly, check valve should be inspected to ensure that nothing has been caught in the seal which might prevent their proper operation. Auxiliary power sources should be started and alarm systems checked.

Care should be taken in this daily inspection and any minor faults should be looked after immediately to prevent them from becoming major faults which might cause a shut down of the station.

CHEMICALS IN SEWER CLEANING

The use of chemicals in the cleaning of sewers is becoming more and more common especially in the clearing of grease which has become a major problem in many large centres.

There are various types of chemicals that can be used as dispersants for grease, however, care must be exercised in their use. Some chemicals will emulsify grease and carry it downstream, however, the further down stream the emulsion is carried the weaker it becomes and eventually the grease will reform and cause further blockages.

With the greater use of plastic pipes, care must be taken to ensure the chemicals used will not attack plastics and cause a complete deterioration of the sewer. Examples of these are organic

solvents such as carbon tetra chloride and trichlorethylene.

GASOLINE

Gasoline leaks can come about in a number of ways, leaks in tanks at service stations, accidental damage to gasoline transport truck, leaks in storage tanks, etc. When these occur large amounts of gasoline can find its way into the sewer system and when it does a highly dangerous situation exists.

Gasoline is dangerous when the proper mixture of gas and air is present to bring the mixture into the explosive range. Mixtures above and below this range are safer, however, to reduce a mixture that is above the explosive range to one that is below it you must pass it through the explosive range and this is highly dangerous.

If explosive or near explosive mixtures are found in sewers the local fire department and the Energy Board of the Ministry of Consumer and Commercial Relations should be notified immediately. Inexperienced personnel should not attempt to remove explosive mixtures from sewers. All equipment in the area should be shut down and if possible the area blocked off.

Every attempt must be made to find the source of the leak if it is not known. This can be done by checking all potential sources such as service stations, garages, etc. to see if the gas they are pumping coincides with the gas they are receiving. When the source is found it must be repaired immediately.

OIL AND HAZARDOUS MATERIAL SPILLS

From time to time accidents will occur which will allow oil or other hazardous materials detrimental to the environment to be spilled.

These spills will be of varying degrees of severity, depending on the material spilled, the amount and the proximity to any sewer system. Subsequent action will depend on these three factors.

It is imperative that the first municipal employee at the scene of any accident of this nature take every step necessary to prevent the spilled material from entering any sewer system that might discharge into an open watercourse.

It is imperative that all municipal employees who are charged with the responsibility of dealing with hazardous spills should be familiar with the:-

Province of Ontario Contingency Plan

For Spills of Oil

And Other Hazardous Materials

Status Report

May 1973

If you do not have a copy of this report, one may be obtained by writing to:

Contingency Planning Officer,
Industrial Wastes Branch,
Ontario Ministry of the Environment,
St. Clair Avenue West,
Toronto, Ontario.

BASEMENT FLOODING

Basement flooding can be the result of overloaded main sewers, blocked main sewers or blocked sewer connections. The damage done during basement flooding can vary from slight in unfinished basements to serious water and structural damage, depending on the reason for flooding.

Blocked sewer connections usually result in the least amount of damage as the water entering the basement is confined to that used in the house itself. Signs of impending backup are often present such as water rising in floor drains, and if these signs are noted by the resident steps can be taken to rectify the problem before it becomes serious.

How a municipality handles blocked sewer connections is a matter of their own choice. The ways they are handled are as diverse as the number of municipalities although the basic principles may be the same. Many believe, that, as the residents are the only ones putting material in a connection they are responsible for all blockages regardless of where they occur except those that are caused by a structural failure of the pipe within the road allowance.

The determining of the nature and location of blockages is where most differences exist. Some put the onus on the resident to show where the blockage is and some make it a responsibility of the municipality. Whichever method is used, careful records should be kept of blockages on the road allowance and if a history of blockages becomes evident repairs should be made.

Overloaded or blocked main sewers usually cause the greater amount of damage. Sanitary sewer backups will allow a considerable amount of sanitary sewage to enter the basement through the floor drain. The amount of water entering will depend on the amount of surcharge in the sewer and the difference in elevation between the sewer and the basement floor. The damage to the finished floors and walls and the contents of a basement can be considerable but very little structural damage results.

If storm sewers back up and weeping tiles are connected to them considerable structural damage can result. The water exfiltrates through the weeping tiles and builds up a head around the outside of the walls. As the head increases the pressure on the basement floor also increases, eventually it bursts and the water enters. The damage to the contents is the same as that sustained in a sanitary back up but the extra damage to the floor footings weeping tile and walls is often considerably greater. For this reason many municipalities are prohibiting the connecting of weeping tiles to storm sewers.

When extensive basement flooding occurs basements should be cleaned up and disinfected as soon as possible. As most home owners are not equipped to clean up situations of this extent, some municipalities will undertake to do it where possible, on the understanding that any work done by them does not constitute an admission of liability.

RECORDS AND MAPS

Complete records should be kept on all sewers. These records should consist of; when the sewer was built, who designed it, who constructed it, type and size of pipe, slope and direction of flow. All inspections of the sewer should be recorded, who inspected it, how it was inspected, what was the condition of the sewer at the time of inspection, and what was the reason for inspection. Every blockage should be noted, overloadings and houses affected should also be recorded.

All this information should be placed on one file card so that when any information is required it is immediately available.

Maps of a scale of two hundred feet to the inch should show every sewer in an area, location of manholes, distance between manholes, type of pipe and direction of flow. Plan and profiles of all streets

should also be available.

Sewer maintenance is an important part of a municipality's work program regardless of its size. Poor sewer maintenance can cause great expense and inconvenience to both the municipality and its residents it can also be a factor in causing pollution of lakes and streams in the area. The cost of an efficient maintenance program is often less than the cost of repairing damage done by sewer backups.

industrial waste problems

in sewer systems

SECTION 2

INDUSTRIAL WASTE PROBLEMS IN SEWER SYSTEMS

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SECTION 2

INDUSTRIAL WASTE PROBLEMS IN SEWER SYSTEMS

This chapter is an attempt to explain some of the problems that can be caused by industrial wastes in sewer systems. Industrial wastes after leaving the sewer system and entering the sewage treatment plant often cause severe problems as well, but these will not be dealt with here.

Sewage collection systems are generally designed and operated on the basis of handling municipal wastes that are of fairly uniform quality and are received in quantities that follow an expected pattern throughout the day and from one day to another. Since it is generally necessary to accept industrial wastes into municipal sewer systems, it is important that problems that can arise are recognized and appropriate action taken to protect the sewers.

Industrial wastes vary widely in quality and quantity from one process to another, from hour to hour through the operating day, and from one day to another. The characteristics that can be expected to differ from those of "normal" sanitary sewage are discussed in the following sections, with recommended control requirements or limits.

Flow:

Excessive industrial flow or widely fluctuating flows can hydraulically overload a sewer system with the possible result of basement flooding or overflows of sanitary sewage to a waterway.

Flow rates through a sewer system are often restricted by the capacity of a pumping station rather than by sewer size. High periodic flows often occur when an industry is working on a batch or semi batch schedule. When such flows become a problem the industry should be advised to study its waste producing operations and eliminate flows from them as much as possible. If the flows cannot be reduced, then the industry should be asked to provide flow equalizing facilities and if necessary to discharge more during low flow periods in the sewer system. Clean cooling water should be segregated and discharged to storm sewers, to open watercourses or preferably should be cooled and recycled by the industry.

Temperature:

High temperatures of industrial effluents may accelerate corrosion, place thermal stresses on piping materials, adversely affect jointing materials, and cause excessive biological action in the sewers. It is customary to place an upper limit of 150°F. on the temperature of industrial wastes discharging to sewers.

pH:

This waste characteristic presents many problems in both sewers and treatment plants. It can sometimes go undetected in sewer systems until a serious localized problem develops. Low pH or acidic wastes can corrode some sewers. They can also corrode piping, pumps and other components of the pumping stations in the sewer system. High pH or alkaline wastes can cause scaling in sewers and on equipment. Most pH problems are caused by dumping of acidic or alkaline industrial wastes. Alkaline metal cleaners,

stripping acids (pickling liquor) and regeneration of ion exchange water treatment systems are a few sources of such wastes. Because of pH being represented on a logarithmic scale, dilution does not usually solve pH problems. One gallon of a strong acid with a pH of one would generally require a million gallons of water to raise the pH to approximately seven. Dilutions of this magnitude are uneconomic and could hydraulically overload the sewer system.

Many industries often produce widely fluctuating pH wastes. These industries should be encouraged to provide equalizing tanks to produce an effluent with a pH between 6.0 and 9.5 and which will remain within these limits on dilution when discharged into the sewer system. Wastes outside these limits should not be discharged. The industries should also be required to monitor their pH continuously and provide for emergency shutdown if the pH limits are exceeded.

The measurement of pH is often done by using litmus paper however it is usually not a reliable method. The use of portable pH meters is recommended for tracing a problem source of pH. The addition of recording devices is sometimes necessary to monitor a waste 24 hours a day.

Acidity and Alkalinity

For purposes of this section, acidity and alkalinity are distinct from acid pH and alkaline pH in the following manner. Some acids, called weak acids, do not completely ionize in water as do the strong acids unless the hydrogen ions produced are removed from solution by reaction with a neutralizing solution.

It is the concentration of hydrogen ions that determines the pH. Since it does not completely ionize, the weak acid will show a pH closer to 7 (neutral) than if it had completely ionized. The addition of the neutralizer however removes hydrogen ions, allowing the weak acid to ionize further. During this neutralization process, the pH of the solution would not change as rapidly as expected until complete ionization of the acid had taken place. As an example to illustrate what happens, it may require the same quantity of sodium hydroxide to neutralize a tank full of acetic acid (a weak acid) at a pH of 6 as it would to neutralize the same tank full of nitric acid (a strong acid) at a pH of 1. A similar situation exists with respect to weak and strong bases or alkalis. Weak acids and bases are said to have reserve acidity or alkalinity.

Based on the above, the important point to remember is that measurement of pH alone is not a reliable measure of the amount of acid or base present.

Wastes with a high alkalinity, usually in the form of carbonates, can result in calcium carbonate scales being deposited in sewers, resulting in a reduced diameter and increased surface roughness, both of which reduce the capacity of the sewer.

Industries found to be discharging wastes high in acidity or alkalinity should be asked to provide neutralizing facilities.

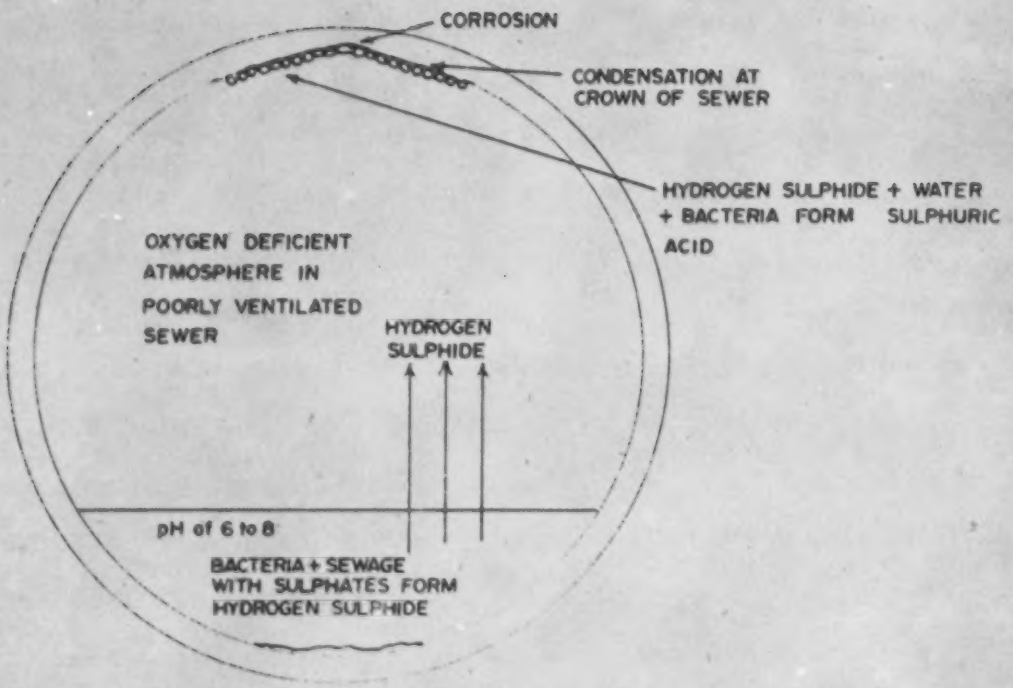
Acidity and alkalinity are measured in the laboratory using titration procedures. The procedure is simple enough that a field kit could be used if necessary.

Sulphate

If wastewater temperatures are high, detention times in the sewer long, and sulphate concentrations appreciable, then "crown" corrosion of concrete sewers can be a significant problem.

Concrete sewers provide an unusual environment for biological changes in the sulphur compounds present in wastewaters. These changes require oxygen and if sufficient amounts are not supplied through natural reaereation from air in the sewer, reduction of sulphate occurs, and sulphide ion is formed. At normal domestic wastewater pH of 6 to 8 most of the sulphide is converted to hydrogen sulphide which escapes into the atmosphere above the wastewater. This gas will do not damage providing the sewer is well ventilated and the walls and crown are dry. However, in poorly ventilated sewers with moisture collected on the crown and walls, hydrogen sulphide dissolves in the moisture. Bacteria then oxidizes the hydrogen sulphide to sulphuric acid and it is this acid that attacks the sewer. The problem is particularly serious at the crown or top because condensation run off is a minimum and a concentration of the acid develops.

In order to alleviate this problem, sewers should be well ventilated. In addition, elimination of industrial wastes containing the sulphates should be attempted, when a problem occurs. It is suggested that sewers be tested for oxygen levels and hydrogen sulphide levels with portable metering equipment to locate sections of sewer that could be prone to crown corrosion.


CORROSION
CONDENSATION AT CROWN OF SEWER
HYDROGEN SULPHIDE + WATER + BACTERIA FORM SULPHURIC ACID
OXYGEN DEFICIENT ATMOSPHERE IN POORLY VENTILATED SEWER
HYDROGEN SULPHIDE
pH of 6 to 8
BACTERIA + SEWAGE WITH SULPHATES FORM HYDROGEN SULPHIDE

CROWN CORROSION MECHANISM

Floating or Settleable Solids

Wastes high in suspended solids may result in clogging and blocking of pipes. Sewers are normally designed to carry suspended solids without deposition, however the solids produced by an industry if heavier or in much greater quantities than normal can deposit in the sewers during normal or lower than normal flows. Some such materials if organic in nature could then produce obnoxious odours from the sewers. These materials will usually be moved during high flow periods. They can also cause problems by depositing in pumping station wet wells and by reducing the hydraulic capacity of overflow structures. Wastes containing fibrous materials, even though individual fibers are small,can readily clog sewers by forming into large strings and ropes. Rags, feathers and other larger pieces of industrial waste can become stuck on minor obstructions within a sewer and rapidly build into a substantial blockage. They also quickly clog screens at pumping stations requiring them to be cleaned frequently.

Industrial wastes should not have a suspended solids concentration of greater than 350 parts per million and should not discharge any material which might interfere with the operation of the sewers. Examples of materials which should be controlled are ashes, cinders, sand, earth, mud, straw, metal, glue, glass, pigments, rags, textiles, tars, plastics, cellulose, wood, products, animal wastes and canning wastes.

Toxic Materials:

Some materials in industrial wastes can be toxic to the personnel working on sewer cleaning and maintenance of pumping stations. Examples of this are any waste that produces hydrogen cyanide gas or hydrogen sulphide. Hydrogen sulphide is produced from the decomposition of organic material and can occur in any sewer in which the detention time is long enough or the flows are low so that deposition occurs. Hydrogen cyanide gas is produced from sodium cyanide when the pH is acidic. If sodium cyanide is found to be present then for the safety of operators or sewer workers, the pH should be kept above 9 until the source of the sodium cyanide can be eliminated. Hydrogen cyanide concentrations over 10 ppm are dangerous. It is suggested that a maximum limit of 2 ppm be observed. The limits on Hydrogen sulphide can be found in the safety section of this manual.

Hydrogen Sulphide and hydrogen cyanide can be tested for with a portable gas analyzer fitted with the appropriate ampoule.

Inflammable or Explosive Materials:

The possible consequences of having inflammable or explosive material in a sewerage system are obvious. It is generally agreed that such materials are seldom, if ever, deliberately discharged to the sewers, and, in most cases, discharges are due to unsatisfactory industrial plant operations or spills or leaks in equipment. Industry should be required to undertake all feasible precautions to minimize the possibility of any such substances reaching the sewers. The installation of such safety measures as

alarms, gravity separation traps, normally closed valves to sewers, and similar safeguards, should be agreed upon between the municipality and the industry.

Greases, Fats and Oils

Greases and fats are often discharged in hot liquids and as long as the temperature is above the melting point of the fat, no inconvenience is caused in the sewers. However, in cooling the fat solidifies and builds up in layers, often greatly reducing the flows in sewers. Build ups of grease and fat often causes the malfunction of pumping stations usually by blocking air bubbler systems or by building up on floats or electrodes used to start and stop pumps. Oil, on the other hand forms films on water surfaces,on sewer walls, ladder rungs and equipment and generally makes a mess. It is suggested that wastes, which contain any volatile oils, or more than 100 parts per million, by weight, of fat, oil or grease of animal or vegetable origin, not be discharged to the sewerage system.

Malodorous Gases

Some gases, when discharged in industrial wastes, are vented to the atmosphere from manholes or at the primary works of a sewage treatment plant, creating offensive conditions in the surrounding neighbourhood. Not only do these gases cause foul odours but, in sufficiently high quantities, can be poisonous and can prove fatal to men working in the sewers. All noxious or malodorous gases or substances capable of creating a public nuisance, including hydrogen sulphide, carbon disulphide, carbon monoxide, and ammonia, should not be discharged to the sewerage system.

Dissolved Salts

Certain salts which may be in solution initially, when contacted by wastes from another source, may precipitate and lead to undesirable conditions. For example, a waste containing dissolved iron salts, within the recommended pH range, may, on dilution in the sewer, precipitate these salts and thus drop the pH and release free acid which would attack the sewers. Monitoring the sewer system for pH remote from the industry is required to track down such wastes. When found, the offending industry should be required to install equipment to precipitate and remove the salts before discharge to the sewer system.

Radioactive Wastes

Although the problems associated with radioactive wastes are not normally encountered at the present time, it is expected that in the future these wastes may be present and will require very close controls to protect the public and personnel associated with the sewage system. It is suggested that a municipality in which industries could be using radioactive materials should contact the industry to find out what if any controls are being practised by the industry and then take the appropriate action required.

The regulation of the use and disposal of radioactive materials is the responsibility of the Federal Atomic Energy Control Board which operates under the terms of the Atomic Energy Control Act RSC 1952 Chapter 11. It is suggested that reference be made to this act in dealing with the regulation of radioactive materials.

BOD

Although consideration of BOD would normally be confined to the treatment process, it should be noted that high strength BOD wastes can result in the depletion of dissolved oxygen within the sewer, the creation of septic conditions, production of odours, changes in pH, crown corrosion, and probably an infinite number of other side effects when combining with other industrial wastes. It is suggested that the usual limits of 350 ppm be adhered to.

The above recommended controls, if put into effect through sewer use bylaws, examples of which can be found elsewhere in the manual or from the Ministry of the Environment, should provide adequate protection of sewerage facilities. The same controls that are intended to protect the physical facilities and guard against the discharge of flammable or explosive substances and the emission of toxic gases in sanitary sewers should be applied to storm sewer use as well. In addition, since wastes that are discharged to storm sewers do not receive treatment prior to discharge to the receiving waters, control limits at the point of discharge to the storm sewer must be in keeping with the suggested limits according to the model bylaw for discharge to open watercourses. (BOD, suspended solids, toxic metals, etc.).

For those who are interested in additional details on industrial waste problems, especially with treatment plants and how to deal with them, it is recommended that a copy of

"Industrial Waste Bylaw Enforcement Course" September 1970 sponsored by the OWRC - City Engineers Association Advisory Committee be obtained.

safety practices and operator protection in sewer systems

SECTION 3

SAFETY PRACTICES AND OPERATOR PROTECTION IN SEWER SYSTEMS

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SECTION 3

SAFETY PRACTICES AND OPERATOR PROTECTION IN SEWER SYSTEMS

INTRODUCTION

The dangers associated with sewer system operation emphasize the need for safety practices. Physical injuries and body infections are a continuous threat and occur with regularity. Explosions and asphyxiations from gases or oxygen deficiency can occur during sewer and pumping station maintenance, and although infrequent at any particular location, on a country-wide basis many such accidents occur. These occupational hazards may be largely avoided by the execution of safe practices and the use of safety equipment. The dangers are many and carelessness all too frequently prevails until an accident results. Then it is too late.

It is the responsibility of sewer system supervisors to acquaint themselves with the hazards associated with sewer maintenance and operation, and to take steps to avoid them. Accident prevention is the result of thoughtfulness, and the application of a few basic principles and knowledge of the hazards involved. It has been said that the "A, B, C" of accident prevention is "always be careful". However, one must learn how to be careful and what to avoid. With this knowledge one can then always think and practice safety.

The overall dangers of accidents are much the same whether in manholes, pumping stations or treatment plants. These hazards may be as follows:

1) Physical injuries
2) Body infections

3) Dangers from noxious gases or vapours, explosive gases and oxygen deficiency

4) Chlorine gas from defective equipment

5) Gasoline and volatile solvent hazards

6) Radiological hazards.

These hazards may, in some cases, be inherent in design that, once recognized, can be readily corrected or can, at least, be guarded against by warnings and by proper safety procedures as outlined in the following sections.

PREVENTION OF PHYSICAL INJURIES

The prevention of physical injuries begins with good housekeeping. Tools, parts and other equipment should not be left lying around. Be sure warning signs, railings and covers are in place to protect against low piping, open tanks and open manholes or hatches. The simple knowledge of bending the knees and lifting with the muscles of the legs can save many strained or injured backs or ruptures. Turning heavy loads by shuffling the feet rather than by twisting the back is recommended. Posters illustrating many injury saving techniques can be seen at most industrial plants.

Manholes

For work in manholes in streets, safety requires full protective measures from traffic hazards as well as atmospheric hazards. Warning signs and red flags should be set up at a suitable distance on each side of the manhole. On extremely busy streets, it may be desirable to station men to flag down and detour fast-moving vehicles in accordance with the

traffic detour manual. On wide streets, the service truck can be stationed on the side of the manhole toward the oncoming traffic.

When using the service truck close to the manhole, it is important to turn off the motor. (Motors are sometimes left on when the truck is equipped with a two way radio). Exhaust fumes from the truck can and will drift down into the manhole. It is important that sufficient workers be provided for the job at hand. There should be at least two men at the top when one goes below. A cage or guard device around the manhole as protection aids entering and leaving the manhole. Manhole covers should be lifted with a hook made to fit a ventilation hole or lifting notch. A pickaxe may slip and cause injury or, if struck hard, may give off an igniting spark. Unless a cover is very heavy, it is safer for one man to handle it alone.

Before descending into the manhole, and after testing for explosive gases or oxygen deficiencies by the methods described later, note should be taken of the width, spacing, and arrangement of manhole rungs. Each rung should be tested with your foot before putting your full weight on them and your weight should be distributed between feet and arms. Steel rungs may lose their galvanizing and corrode to a dangerous extent. Be extra careful if the soles of your boots are worn smooth to prevent slips that could lead to injuries. Always wear gloves to protect the hands against infection. Plastic coated cotton gloves are better than neoprene rubber gloves as the latter get very slippery if the ladder rungs are wet.

Safety Harness

No one should enter a manhole of 5 feet or more without wearing a safety harness and rope. The harness should be a C.S.A. approved parachute design type with the rope fastened to the lifting ring located on the back where the shoulder straps cross. Do not use a safety belt as a man cannot be lifted in a vertical position by a belt around his waist. A safety harness must always be worn when entering any confined space such as pump suction wells and overflow chambers regardless of size or depth.

Lighting

Wherever some light can be reflected by the use of mirrors into a manhole or other enclosed space, it gives excellent and safe lighting. Otherwise, even in the absence of flammable gases, safe practice dictates the use of an explosion-proof extension lamp. Only grounded explosion-proof extension lamps or explosion-proof portable lamps should be used in hazardous locations.

Electrical Hazards

Electrical shock hazards are present in many of the older pumping stations. New types of enclosed switch gear are quite safe, but the older open types of switchboard need to be approached with care. A rubber mat on the floor is an added safety factor for either type. Grounding of all equipment is essential.

Never enter a pumping station in which water has flooded over the electrical equipment without taking precautions to prevent shocks from power being carried through the water.

If possible shut off all power and use portable equipment to pump out the station. When work is to be done on equipment controlled by a switch located at some distance from the equipment, the switch should be locked out with a suitable padlock for which the serviceman has the only keys. A red warning tag should also be attached advising that the circuit is being worked on. Before returning to service, the equipment should be checked for other crews working on it.

Ladders

Fixed vertical ladders over 16 ft. in height should be equipped with some means of providing a resting spot for those using the ladder. Various means are available but two that are widely used are platforms at specified intervals and hoops on the ladder. Any such system should be designed with care however, since the usual result of their installation around pumping stations and manholes is to impede the use of sewer cleaning equipment or the removal of pumps or even unconscious workers from these areas. The end result could be removal of these protective devices in order to get the work done.

Portable ladders should be used carefully and should be properly secured by tying at the top or wedging at the bottom or both. Extension ladders should not be over extended resulting in a short overlap of the two sections.

Fire Extinguishers

It is recommended that fire extinguishers suitable for electrical fires be provided in readily available places at pumping stations. Extinguishers using carbon tetrachloride are no longer used. In closed spaces, there is a danger of

asphyxiation from noxious fumes which may result from the use of a carbon dioxide type. Therefore adequate ventilation should be provided. For fires other than electrical, the soda ash and acid type of extinguisher is satisfactory. Foam extinguishers, dry chemical type extinguishers and buckets of sand may be used in some areas for smothering small fires.

PREVENTION OF BODY INFECTIONS

Workers who come into contact with sewage are exposed to all the hazards of water-borne diseases, including typhoid fever, amoebic dysentery, infectious jaundice, and other intestinal infections. Tetanus and skin infections must also be guarded against.

First Aid

Except for minor injuries, wounds or injured personnel should be treated by a qualified nurse or medical doctor. Service trucks should have sufficient first aid kits for personnel who are holders of valid first aid certificates of the Province of Ontario. No cut or scratch is too minor to receive attention. All employees should be encouraged to train in the area of first aid.

Wearing Apparel

Rubberized cotton gloves afford good protection to the hands. In wet places, rubber boots or rubber overshoes protect the feet from dampness and infection. The use of shoes or boots with safety steel toes is recommended. Work clothes or coveralls should be worn in dirty places such as manholes, and should be laundered frequently. Rubberized fabric suits with hoods which can be washed off with a hose can be purchased for extremely dirty jobs.

Personal Habits

Smoking should not be permitted in sewers or in other hazardous locations. Smoking is a potential source of ignition for any flammable vapours present as well as a possible route for infection to enter the body.

An excellent rule while at work in sewers, pump suction wells or while handling sewage or sludge is "keeping the hands below one's collar". A majority of infections reach the body by way of the mouth, nose, eyes or ears. Hands of sewer system workers should be washed before smoking or eating. Soap preparations requiring no water rinse can be purchased for field use. The common drinking cup should be banned. Typhoid and tetanus inoculations are recommended. These may be obtained free-of-charge from the local health officer.

NOXIOUS GASES OR VAPOURS, EXPLOSIVE GASES AND OXYGEN DEFICIENCY

The industrial safety act states that "no Workman shall enter any confined space until the atmosphere of such space has been tested for oxygen deficiency, combustible gas and toxicity and such tests have been proven negative". This rule should be applied to sewer systems.

For a full understanding of the hazards from noxious gases, vapours, explosive gases, and oxygen deficiency the following definitions are given:

Vapour is the gaseous form of a substance that can exist also in the form of a liquid at common temperatures and pressures. Water vapour and gasoline vapour are examples. A noxious gas or vapour is one that is directly injurious or destructive to the health or life of humans. They may cause

burns, explosions, asphxiation or poisoning. Non-poisonous gases may asphyxiate simply by mechanically excluding oxygen.

Sewer gas is a misnomer since it is not a single gas but a mixture of gases from the decomposition of organic matter. It is actually a sewage sludge gas with a high content of carbon dioxide and varying amounts of methane, hydrogen, hydrogen sulphide and a small amount of oxygen. The hazard is usually from an explosive mixture of methane and oxygen or, more often, from an oxygen deficiency. This definition does not include the extraneous gases or vapours which may be present in sewers from gas main leaks or from gasoline or other volatile solvents which frequently find their way into sewers.

Oxygen Deficiencies

Air normally contains a volume of about 21% oxygen and 79% nitrogen and traces of other gases. Air containing less than 16% oxygen by volume is decidedly dangerous to humans. The industrial safety act states that "A confined space in which there is an oxygen content in the atmosphere of less than 18% or more than 23% shall not be entered unless the entry, Sections 83 and 87 of the Industrial Safety Act have been complied with". Oxygen deficiency appears to be the leading cause of death in sewers. It is likely that some deaths attributed to hydrogen sulphide may actually have been caused by an oxygen deficiency.

Explosive Conditions

Flammable or explosive gases when mixed with air or oxygen will explode violently upon ignition with a spark

or flame provided the gas and oxygen or air mixture is within a certain percentage range. As an example, methane has an explosive range of 5% to 15% by volume in air. No explosion will occur when the mixture is outside this range. The minimum concentration is known as the lower explosive limit, while the maximum concentration for explosion is called the upper explosive limit. These are respectively the leanest and richest mixtures needed for an explosion. Reference should be made to the table at the end of this chapter, for the characteristics of common gases encountered in sewers and waste water pumping stations.

Hazardous Locations

The atmosphere of confined spaces and other work areas which are most likely to be contaminated from a noxious gas or vapour or oxygen deficiency, must be carefully tested and rendered safe prior to entry. Some of these areas are as follows:

1) All large trunk sewers, particularly in industrial areas.
2) Sewers located in the vicinity of gas mains and gasoline storage tanks.
3) Sewers on flat grades where solids may settle and decompose.
4) Sewers with manholes over 300 feet apart, particularly if solid manhole covers are used and the houses connected to the sewers have main sewer traps which prevent ventilation through house stacks.
5) All sewers and manholes more than 10' deep.
6) Any tightly covered pit, tank or valve chamber, regardless of depth.

7) Deep tanks, and pump suction wells.

Order and Type of Test

Tests should be made in the order given below. Samples may be taken through a ventilation hole in a manhole cover, under a cover removed partially, or with the cover entirely removed. Care must be taken in all cases to avoid the creation of sparks.

a) Test for Oxygen Deficiency

The use of a portable oxygen deficiency meter is recommended and can be obtained from the safety equipment dealers. It should be noted that this test must be taken before testing for flammable gases since flammable gases will not burn in the test unit when there is no oxygen.

b) Test for Flammable or Explosive Gases

These may be detected by relatively inexpensive combustible gas indicators. These instruments are battery operated units which oxidize or burn a sample of the atmosphere under test over a heated catalytic filament which is part of a balanced electrical circuit. Any combustible gas or vapour in the test sample, if oxygen is present, will unbalance the circuit causing a deflection of an indicating needle to show on a scale the concentration of combustible gases or vapours in the sample. Twenty percent of the lower explosive limit should be considered hazardous. The sample is obtained by a tube or probe lowered to the desired depth in the structure and a rubber bulb is squeezed to pump to the sample through the unit. The instruments are usually calibrated for petroleum

vapours and do not give exact accuracy for other vapours, however they are sufficiently close to be adequate for complete safety of personnel.

c) Test of Hydrogen Sulphide

Lead acetate in a cotton mesh covered ampoule in the atmosphere under test for one minute, turns from a yellow to brown colour in the presence of hydrogen sulphide. The colour is compared to a chart which indicates concentrations from five to twenty-five ppm. A concentration of 20 ppm is the maximum allowable for eight hour of exposure to humans. Hydrogen sulphide may also be tested for by using a Drager Meter or other portable gas analyzing apparatus with the appropriate ampoule attached.

d) Test for Carbon Monoxide

This gas is tested for using a portable gas testing unit using the appropriate ampoule. In this case the ampoule contains palladium chloride which turns from yellow to dark grey when exposed to the gas. The exposure time is 10 minutes at normal temperatures and 20 minutes for temperatures below freezing. The maximum allowable concentration for an eight hour exposure is 100 ppm.

e) Other Gases

Ampoules for use with a large variety of gases and portable test units are available. A list of some of the ampoules available is appended although most of them are not likely to be required in sewer work.

Condition of Test Equipment

It is important that test equipment be checked regularly for reliability by testing with a known sample.

Unreliable Testing

The use of canaries, relying on the detection of odour alone, and even ventilation of sewers without testing may be hazardous procedures. Birds require much less oxygen than humans and can build up a tolerance to carbon monoxide. Some of the hazardous gases are odourless and continued ventilation, when a gas leak is serious, may not correct a hazardous situation. The safest method is the sure method of testing with the proper instrument.

Summary of Safe Practices

Condition I - Tests show no hazardous situation as to gases, vapours or oxygen deficiency.

Workmen entering sewers or enclosed places over 10' deep should wear safety harness with at least two men available at the surface. Even though tests show no hazards, the situation may be changed or the workmen may be injured. No one should smoke within the manhole and sparks from tools should be prevented by the use of non-sparking, beryllium-copper alloy tools. Rubbers should be worn on the feet, and only approved safety lighting should be used. Tests should be repeated at intervals if the work is prolonged and should also be repeated at depths greater than sampled before entering the manhole.

Condition II - Tests show noxious gases or vapours or oxygen deficiency. The structure should be thoroughly ventilated with extreme care taken to avoid ignition of flammable gas and retested. Ventilation of manholes may be carried out in one of several ways:

1) by placing a canvas or metal deflector to direct natural air currents into the manhole with adjacent manhole covers removed. Moderate to strong winds are necessary.
2) a fire hose stream directed into the manhole with adjacent covers open may create sufficient draft.
3) introduce compressed air from a hose to a point near the bottom of the manhole.
4) use a portable blower with discharge hose well down in the manhole, and with engine or motor driven unit well away from the manhole to prevent ignition and to keep exhaust fumes away. After thorough ventilation, and tests indicating a safe situation, proceed as in Condition I.

Condition III - Tests show a hazardous situation, but an emergency exists because of flooding or a workman may have been overcome. Workman, in addition to the provisions of Condition I, must be equipped with the proper type of respiratory apparatus. If tools are needed, only non-sparking types should be used. Great care must be exercised to avoid all sources of ignition. Work in flammable gas atmospheres is extremely hazardous and must never be attempted except by those fully aware of the dangers.

SAFETY WITH CHLORINE

Although most sewer systems do not use chlorine there is the occasional pumping station equipped with standby chlorination facilities. Chlorine may also be used where sewage

is being bypassed to a river due to emergency conditions. Cylinders and ton containers should be stored in a cool, dry place away from direct sources of heat and away from combustible flammable materials. It is recommended that cylinders be stored on end and ton containers on their side, both with valve protectors in place.

Connections to cylinders and containers are made by clamp adaptors or by union connections. See that connecting surfaces and threads are clean and always use a new gasket of standard material. On making a new connection, open the valve slightly and test for chlorine leakage with a swab wet with ammonia and held close to the valve and connection. White fumes of ammonium chloride indicate a leak. Leaks around valve stems can be easily stopped by tightening the packing nut slightly. All connections in chlorine lines should be tested frequently.

The provision of canister type gas masks for emergency use is not recommended. A demand type breathing apparatus is best and should be stored near the chlorine storage area but far enough away that it can be reached during an emergency.

GASOLINE AND VOLATILE SOLVENT HAZARDS:

In pumping station wet wells and overflow chambers, flammable vapours of gasoline and other volatile solvents may come in from a sewer and accumulate at low points. Gasoline vapour is heavier than air, and presents all the hazards of asphyxiation and explosion. Such places should be provided with forced ventilation. All electrical switches, lights, motors and fixtures should be explosion-proof, and smoking

absolutely prohibited. Tests should be made frequently for these vapours as described previously and, when found, investigation should be made to determine the source.

RADIOLOGICAL HAZARDS

Studies by the United States Public Health Service indicate that dilution in the average sewer system together with the usual safeguards in handling such material are normally adequate to prevent the creation of any health hazard. In Canada, the Atomic Energy Control Board keeps tight control on the use and disposal of atomic wastes. In war time a radioactive hazard might occur in sewers following an underwater or ground burst of an atomic bomb. Portable geiger counters may be used to detect harmful radiations. The use of these instruments and others can be learned from the literature dealing with these items.

RESPIRATORY PROTECTIVE APPARATUS

Demand Type Respiratory Apparatus

This type of apparatus should be used when entering any confined space that cannot be purged and ventilated to provide and maintain a safe atmosphere. The apparatus should be of a self contained fresh air pack with a 15 to 30 minute air supply.

If longer periods of time are required for entry then a demand type of face piece with a hose connected to a large fresh air tank may be used. A hose mask is suitable for all atmospheric conditions in sewers or other confined spaces.

The demand type of apparatus uses a fresh air supply and does not depend on using any of the contaminated atmosphere. They are all limited however by the capacity of

the portable tanks or in the hose type by the length of the hose.

Self-Contained Breathing Apparatus

One type of oxygen supplying equipment consists of a canister containing a chemical, potassium tetroxide, a vigorous oxidizing agent, which supplies oxygen. This device is not recommended for use in sewer manholes, pump suction wells or other locations where oil, grease or gasoline might come into contact with the neck of the canister and cause deterioration and combustion with dire results.

Another self-contained device supplying oxygen from a cylinder, has a rubber breathing bag, a regenerator and mouth piece, with the necessary regulating valves. This device is also hazardous in atmosphere containing petroleum vapours and should only be used in their known absence.

Canister Type Masks

This type of apparatus uses a filter canister to remove the offending gas. A separate canister is required for each type of gas to be encountered or multi purpose canisters can be used for some gases in very low concentrations of known gases. In all cases, the canister, when factory fresh, is limited to approximately 2 percent by volume for 10 minutes. Each use or month of storage time reduces the time and concentration of gas the unit can be safely used for.

The canister type does not protect the wearer from a low oxygen condition. If the oxygen is less than 18 percent in the area a self contained breathing unit must be used.

It should be noted that men with beards cannot safely wear any kind of face piece since it will not seal properly.

REFERENCES AND ADDITIONAL READING

It is recommended that a copy be obtained of the Federation of Sewage and Industrial Wastes Association's Manual of Practice No. 1 entitled "Safety in Waste Water Works". This publication contains additional detailed information on the prevention of physical injuries, infections and dangers from noxious gases and oxygen deficiency. It will serve as an excellent guide for a safety course which should be a regular part of inservice training, particularly for the new employees.

The Industrial Safety Act - copies can be obtained from the Industrial Safety Branch, Ministry of Labour, 400 University Ave. North, 9th Floor, M7A 1V7

Safety Regulations for Waste Water Treatment Plants - published by the OWRC, Division of Plant Operations in 1971. Copies can be obtained from the Ministry of the Environment, 135 St. Clair Ave. W., Toronto.

TESTING OF GASES

The following are examples of gases which can be tested for by portable testing equipment.

Acetone
Acetylene
Acrylonitrile
Alcohol
Ammonia
Aniline
Arsine
Benzene
Bromine
Butane
Carbon dioxide
Carbon disulphide
Carbon monoxide
Carbon tetrachloride
Chlorine
Chlorine dioxide
Chloroform
Cyanogen chloride
Ethyl acetate
Ethylene
Formaldehyde
Hydrazine
Hydrocarbon
Hydrochloric acid
Hydrogen
Hydrogen cyanide
Hydrogen fluoride
Hydrogen sulphide
Kerosine
Mercaptan
Mercury vapour
Methane
Methyl bromide
Methyle alcohol
Monostyrene
Nickel carbonyl
Nitrogen dioxide
Nitrous fumes
Olefines
Oxygen
Ozone
Petrolium Hydrocarbons
Perchlorethylene
Phenol
Phosgene
Phosphine
Propane
Propylene
Sulphur dioxide
Toluene
Trichlorethane
Trichlorethylene
Vinyl chloride
Water vapour
Xylene

CHARACTERISTICS OF DANGEROUS GASES ENCOUNTERED IN SEWAGE

GAS	Chemical Formula	Common Properties*	Specific Gravity or Vapour Density (Air = 1)	Physiological Effect*	Max Safe 60-Min Exposure (% by Vol. in air)	Max Safe 8-hr Exposure (% by Vol. in air)	Explosive Range (% by Vol. in air) Lower Limit	Upper Limit	Likely location of highest Concentration	Most Common Sources
CARBON DIOXIDE	CO_2	Colorless, odorless. When breathed in large quantities may cause acid taste. Nonflammable. Not generally present in dangerous amounts unless an oxygen deficiency exists.	1.53	Cannot be endured at 10% more than few min., even if subject is at rest and oxygen content normal. Acts on respiratory nerves.	4.0 to 6.0	0.5	-	-	At bottom; when heated may stratisfy at points above bottom.	Products of combustion, sewer gas, sludge. Also issues from carbonaceous strata.
CARBON MONOXIDE	CO	Colorless, odorless, tasteless, flammable, poisonous.	0.97	Combines with hemoglobin of blood. Unconsciousness in 30 min. at 0.2 to 0.25%. Fatal in 4 hr. at 0.1%. Headache in few hr. at 0.02%.	0.04	0.01	12.5	[illegible].0	Near top, especially if present with illuminating gas	Manufactured gas, flue gas, products of combustion motor exhaust. Fires of almost any kind.
CHLORINE	CL_2	Yellow green color. Choking odor detectable in very low conc. Nonflammable.	2.49	Irritates respiratory tract. Kills most animals in very short time at 0.1%.	0.0004	0.0001	-	-	At bottom.	Chlorine cylinder and feed like leaks.
GASOLINE	C_5H_{12} to C_9H_{20}	Colorless. Odor noticeable at 0.03%. Flammable.	3.0 to 4.0	Anesthetic effects when inhaled. Rapidly fatal at 2.4%. Dangerous for short exposure at 1.1 to 2.2%.	0.4 to 0.7	0.10	1.3	6.0	At bottom.	Service stations, garages, storage tanks, and houses.
HYDROGEN	H_2	Colorless, odorless, tasteless. Flammable.	0.07	Acts mechancially to deprive tissues of oxygen. Does not support life.	-	-	4.0	74.0	At top.	Manufactured gas, sludge digestion tank gas, electrolysis of water. Rarely from rock strata.

* Percentages shown represent volume of gas in air.

CHARACTERISTICS OF GASES (CONTINUED)

GAS	Chemical Formula	Common Properties*	Specific Gravity or Vapour Density (Air = 1)	Physiological Effect*	Max. Safe 60-Min Exposure (% by Vol. in air)	Max. Safe 8-hr Exposure (% by Vol. in air)	Explosive Range (% by Vol. in Air) Lower Limit	Explosive Range (% by Vol. in Air) Upper Limit	Likely location of Highest Concentration	Most Common Sources
HYDROGEN SULFIDE	H_2S	Rotton egg odor in small conc; exposure for 2 to 15 min at 0.01% impairs sense of smell. Odor not evident at high conc. colorless. Flammable.	1.19	Impairs sense of smell rapidly as conc. increases. Death in few min at 0.2%. Exposure to 0.07 to 0.1% rapidly causes acute poisoning. Paralyzes respiratory center.	0.02 to 0.03	0.002	4.3	46.0	Near bottom, but may be above bottom if air is heated and highly humid	Coal gas, petroleum sewer gas. Fumes from blasting under some conditions sludge gas.
METHANE	CH_4	Colorless, odorless, tasteless. Flammable.	0.55	Acts mechanically to deprive tissues of oxygen. Does not support life.	Probably no limit provided oxygen percentage is sufficient for life.		5.0	15.0	At top, increasing to certain depth.	Natural gas, sludge gas, manufactured gas, sewer gas. Strata of sedimentary origin. In swamps or marshes.
NITROGEN	N_2	Colorless, tasteless. Nonflammable. Principal constituent of air (about 79%).	0.97	Physiologically inert.	-	-	-	-	Near top, but may be found near bottom.	Sewer gas, sludge gas. Also issues from some rock strata.
OXYGEN	O_2	Colorless, odorless, tasteless. Supports combustion.	1.11	Normal air contains 20.93% of O_2. Man can tolerate down to 12%. Min safe 8-hr exposure, 14 to 16%. Below 10% dangerous to life. Below 5 to 7% probably fatal.	-	-	-	-	Variable at different levels.	Oxygen depletion from poor ventilation and adsorption, or chemical consumption of oxygen.
SLUDGE GAS	-	May be practically odorless, colorless. Flammable.	Vari.	Will not support life.	No data. Would vary widely with composition.		5.3	19.3	Near top of structure.	From digestion of sludge.

* Percentages shown represent volume of gas in air.

SECTION 4

PREVENTIVE MAINTENANCE PROCEDURES FOR SMALL SEWER SYSTEMS

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SECTION 4

PREVENTIVE MAINTENANCE PROCEDURES FOR SMALL SEWER SYSTEMS

The following guidelines are intended to outline preventive maintenance procedures for small sanitary sewage systems, such as those serving communities of up to approximately 5,000 persons. The system will be taken as including all sewer services, sewers, pumping stations and forcemains necessary to convey the sanitary sewage to whatever treatment facility exists.

A typical example of such a system is that for the Town of Ridgetown currently serving a population of about 2800 persons and including approximately 67,000 ft. of asbestos cement pipe ranging in size from 8 to 18 inches in diameter, 1000 sewer services, and one pumping station.

MANPOWER

Small sanitary sewage collection systems even when operated in conjunction with the sewage treatment facilities, generally do not require full time staff. One part-time operator should be able to carry out most routine duties. He would however have to be able to obtain assistance occasionally, for jobs that require more than one man or involve specialized equipment.

For projects operated by the MOE two types of arrangements are made. In the first type, a contract is established with the local Municipality to have their Works Department or PUC carry out the operation and maintenance duties. The contract is usually renewed annually. In the second type of arrangement a part-time

operator is usually hired by the MOE for routine duties and arrangements are made (either informal or contractual) to obtain the services of local Municipal work forces (e.g. Works Department, P.U.C.) or private sources (i.e. contractors or individuals) for other duties. The part-time operator is responsible for supervision of outside labour.

In municipalities where the MOE is not involved, the operation of a system is handled by various means including the town works department or the P.U.C. The method used depends on local preferences and availability of staff. In some municipalities the sewer system does not receive very much attention.

EQUIPMENT

Due to the limited size of the sewer system it will generally not be practical to purchase all the equipment necessary for maintenance of the sewer system. However some equipment for emergency use will have to be readily available and hence should probably be purchased. In some instances where 2 or more systems are close by it may be possible to purchase one set of equipment for all. The following is a list of recommended purchases:

a) Sewer rodding machine for main sewers
- trailer mounted (for car or truck hitch)
- gas engine drive for rod (for rotation at least and preferably for forward and reverse drive also)
- complete with range of accessories (for the sewer sizes in the system)

b) Sewer rodding machine for service connections

- portable (for transporting in a car trunk or truck by 1 man)
- 110 V electric driven rod (for rotation, and forward and reverse drive)
- with range of accessories (for the service connection sizes in the system)

Note : some municipalities may prefer to leave all lateral cleaning to a plumber or other contractor in which case this item could be deleted.

c) Portable trash pump

- gas engine
- self priming
- for pumping sewage (capable of handling 2 inch diameter solids at least)
- complete with approximately 350 ft. of flexible collapsible hose

d) Miscellaneous tools such as pick and shovels

e) Spare sewer (one or two lengths of the most common sizes)

f) Inflatable sewer plugs and/or sandbags

g) Safety equipment such as barricades, warning flashers, portable ventilation equipment, oxygen test meter, etc. (see safety section)

The purchase of the following equipment probably can't be justified for the sewer system alone. One or two sources of this equipment should be located within a reasonable distance

and informal or contractual arrangement made to have this equipment available in cases of emergency. Projects operated by the MOE usually make informal arrangements with the local Municipal Works Department, or P.U.C., or with a private contractor or equipment rental company, to rent the equipment. Equipment that falls into this catagory includes:

a) Sewer cleaning equipment for main sewers
- high pressure hydraulic flushing equipment preferably truck mounted
- complete with manhole sediment traps

b) Backhoe
- for shallow excavations

c) Shovel
- for deep excavations

d) Air compressor and hammer
- for breaking frozen ground or road pavement.

ANNUAL INSPECTION

At least once per year the entire system of sewers should be inspected to detect potential problems. The inspection should start with a visual check at each manhole including such things as:

a) Location of and removal of manhole lid.

b) Inspection of manhole structure for such things as shifted or cracked frame, loose brick and loose or badly rusted manhole rungs.

c) Signs of sewer obstruction (e.g. high water level, sediment deposition on bottom, scum ring on sides).

d) Signs of excessive storm or ground water infiltration

e) Signs of problem wastes being discharged to sewer. (e.g. oils, acids, caustics, excessive solids, etc.)

f) Debris in manhole itself (e.g. gravel, sticks, wire, etc.).

Any work required as a result of the visual inspection should be carried out as soon as possible. Where obstruction of a sewer section is indicated an attempt should be made to sight through the line using a light and mirror. If this is not possible or if a blockage is known to exist anyway, the section should be rodded and cleaned using equipment discussed earlier.

EMERGENCY MAINTENANCE

Blockages of service connections reported by property owners must be investigated by the operator immediately unless other arrangements have been made. It should be determined if possible whether the blockage is located in the privately owned portion of the service connection, in the publicly owned portion of the service connection or in the main sewer. In the second and third cases, the service or lateral should be rodded with the appropriate equipment purchased for this purpose. Where rodding fails to dislodge the blockage, excavation would be required using rented equipment as outlined earlier.

In the case of obstructions located in the privately owned portion of service connections every effort should be made to hold the property owner responsible and have a private contractor carry out the repairs. Where this is not feasible, the operator could clear the blockage and charge the owner. The actual practice will differ from municipality to municipality depending on local custom, bylaws, policy etc.

SEWER CLEANING

It is expected that a complete sewer cleaning program, over and above any periodic rodding will be necessary at intervals throughout the life of the sewer system. The frequency will depend on the quality of design, construction and operation for the particular sewer system as well as the sewage characteristics as evidenced by the number of blockages recorded over the years.

Sewer cleaning will entail the use of specialized equipment and operators which will usually have to be obtained from a private contractor. High pressure hydraulic flushing equipment appears to be best suited for this work although other systems as discussed in another section can be used. The cleaning program would most likely be carried out under contract, with the sewer system operator acting as inspector for the municipality.

As considerable quantities of water as a percentage of the total flow in small systems will be used during the flushing operation,the operator should advise the operator of the treatment facility, before flushing begins. Flushing should be started at the upstream ends of the sewer system and progress towards the treatment facility so that any material that escapes the sand traps will not be deposited in cleaned sewers.

INSPECTION OF NEW CONSTRUCTION

Installation of small extensions to the main sewer system and of new sewer services would be carried out under the supervision of the sewer system operator.

All sewer services installed between the street line and the building served (on private property) should be inspected and tested at least by a ball test by the sewer system operator as well as the municipalities plumbing inspector. While the latter should have actual jurisdiction over the installation it is very desirable to have the operator familiarize himself with it so as to facilitate any maintenance work that he might have to carry out at a future date.

RECORD KEEPING

A system of recording maintenance work for main sewers and sewer services should be maintained. A separate form for each section of main sewer (between manholes) and for each sewer service is suggested. When maintenance work is performed the date, brief description and approximate labour and material cost should be recorded. Some samples of forms are appended to this section.

PUMPING STATIONS AND FORCEMAINS

EQUIPMENT REQUIREMENTS

Again because of the small size of the system it will likely not be practical to purchase all the necessary equipment for servicing and repair of the forcemain and pumping station. Equipment that should be readily available and hence should be purchased and kept in or close by the station, includes:

a) Small tool set

- wrenches, screw drivers, etc.

b) Come along (hoist)

- ratchet type
- for raising pump motors from overhead hook
- 20' fall

c) Spare parts

- mechanical seal or packing
- float switch or pressure switch depending on control system used
- filters for seal water
- air compressor for seal water supply and bubbler type pump control system (if applicable)
- medium length "C" clamp for forcemain pipe size
- one or two lengths of forcemain pipe

The following equipment will be required occasionally (e.g. for emergencies or periodic checks). It would not likely be necessary to have this equipment at the pumping station but a convenient source should be determined so that it can be obtained within a matter of hours.

a) spare pump

- portable (trailer mounted type)
- gas engine drive
- with pump performance similar to largest pump in pumping station if practical
- self priming
- complete with flexible hose and connections to pump from wet well to bypass on forcemain

b) Metering and measuring equipment for

- current, voltage, resistance (e.g. A.V.O. meter, amprobe)
- vibration (e.g. vibrometer, mechanical (stethoscope)
- rpm (e.g. strobe light)
- temperature

- clearances (e.g. calipers)

c) Emergency chlorination equipment

In some instances, local mechanics and electricians will be used to service the equipment and they will probably have access to the necessary equipment.

INSPECTION SCHEDULE

The actual inspection schedule for a particular station will depend on such factors as type (e.g. prefabricated, submersible, custom built), manufacturers recommendations, existence of flow metering and standby power facilities, etc. It is not possible to draw-up one schedule for all stations.

The attached Inspection Guide is intended for a pre-fabricated station with no flow metering or standby power facilities. At projects operated by the MOE the daily, monthly, 3 month and 6 month items could be carried out by the operator. The yearly items would be checked by a Regional Maintenance Technician.

RECORD KEEPING

A record should be kept of all inspection and maintenance work carried out. A check list should be located in the station, to be signed daily by the operator.

SEWER CONNECTION RECORD SHEET

PROPERTY SERVICED

Street and House No.

Owner

Type of Building

DESCRIPTION OF INSTALLATION

	Main Sewer to Property Line	Property Line to Building
Date of inspection		
Inspected by		
Installed by		
Size and type of pipe		
Unusual features		

Note: Sketch plan view of lateral on back of form showing location of connection at property line and cleanouts, with dimensions to reference points.

MAINTENANCE LOG

DATE	WORK DESCRIPTION	LABOUR (man-hours)

SEWER RECORD SHEET

Description of Installation

Area designation

Street

Upstream manhole no. and location

Downstream manhole no and location

Size and type of pipe

Length

Note: Sketch plan view of sewer on back of form showing manholes with dimensions to reference points.

Maintenance Log

Date	Work Description	Labour (man-hours)

MAINTENANCE INSPECTION GUIDE FOR PREFAB PUMPING STATIONS

Daily

1. Lights and blower should operate when cover is open. Make sure manual switch is off when leaving station as excessive ventilation will cause condensation.
2. Check air supply at compressor storage tank.
3. Check rate of bubble flow (where applicable).
4. Check operating levels.
5. Check sump pump operation.
6. Check dehumidifier for icing and operation.
7. Check filter on seal water supply by bleeding seal while pump is idle. (DO NOT OPEN BLEEDER VALVE WHILE PUMP IS OPERATING). Clean filter when necessary.
8. Check overload reset buttons on all pumps.
9. Listen for peculiar noises.
10. Feel pumps and rotors in operation for heating.
11. Observe action of check valves.
12. Test standby pump operation.
13. Check mechanical seal for leakage. (DO NOT RUN PUMP WITH SEAL LEAKING, AS THIS CAN HARM THE SLEEVE OR SHAFT).
14. Be sure station can operate successfully until next visit.

Monthly

1. Close and open all gate valves.
2. Check sump pump operation and clean sump pit.
3. Check bubbler line for leaks or blockage.
4. Purge bubbler line by turning adjusting knob on regulator to provide greater flow of air. Reset as originally found.

5. Comment on bubbler system and dehumidifier.

3 Months

1. Clean filter on compressor intake.
2. Clean filter bowls or sight glasses on bubbler system.
3. Assess and replace supplies of seal filter elements and parts.
4. Compare operating levels with those 3 months previous to ascertain possible control failure.
5. Clean pressure gauge lines on pumps.
6. Clean filter (seal) lines on pumps.
7. Place orders for expendable equipment on a 3 month prior order basis.
8. Contact Technician on condition of operation.

6 Months

1. Inspect discharge check valves.
2. Check bubbler pipe in wet well and replace if warranted.

Yearly

1. Lubriflush motor bearings
2. Check motor for cleanliness. Ensure air passages are free.
3. Check stator for evidence of heating at connection lugs aged or cracked insulation on windings.
4. Check motor controls for signs of worn pitted or dirty contacts.
5. Check load readings against name plate data.
6. Thoroughly inspect air compressor. Replace any parts that show signs of wearing.
7. Check falk coupling springs. Clean and lubricate.
8. Check condition of Cathodic protection.
9. Take impeller clearances and check impeller fastening. (Bring subject to attention of Technician for advice).

10. Take equipment inventory. Correct data cards if necessary.
11. Take spare parts inventory.
12. Take inventory of tools and evaluate condition.
13. Evaluate pumping rate (for increase or decrease)

preventive maintenance procedures

for large sewer systems

SECTION 5

PREVENTATIVE MAINTENANCE PROCEDURES FOR LARGE SEWER SYSTEMS

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SECTION 5

PREVENTATIVE MAINTENANCE PROCEDURES FOR LARGE SEWER SYSTEMS

The following guidelines are intended as an outline for preventative maintenance of sewage systems serving communities with populations of over 5,000 persons and will include all sewer services, sewers, pumping stations and forcemains necessary to convey the sanitary sewage to the treatment plants.

Preventative maintenance of sewage systems is carried out to accomplish four objectives:

(a) To remove any accumulations whether it be silt, roots or other foreign material, before they reach such proportions that the design capacity is reduced to a point where it is not adequate to carry the flow from the tributary area, thus causing backups into private homes.

(b) To check for any cracked or broken pipes, serious sand and root penetrations, etc., which could require replacement of all or part of the sewer.

(c) To ensure that materials (i.e., industrial wastes) which would harm the actual sewage system or the sewage treatment processes or cause harm to persons working in the sewer, are not discharged to the system.

(d) To ensure that materials (i.e., surface water in the case of sanitary sewers) for which the system is not designed, are not discharged in such quantities that they would overload the system and cause backups into private homes.

The preventative maintenance program actually consists of six operations in all, but all six are inter-related to a greater or lesser extent. These operations consist of:-

Sewage Lift Station Preventative Maintenance
Manhole Inspection
Sewer Cleaning
Sewer Inspection by Camera
Industrial Waste Control
Private Property Inspection

Sewage Lift Station Preventative Maintenance

Sewage lift station preventative maintenance should be carried out daily and all Sewage Lift Stations should be visited by a crew of two men who carry out the following specific duties as required by the maintenance schedule as well as any which may appear necessary at the time of the visit:-

Lubrication
Cleaning screens where applicable
Flush floor and walls of wet well
Operate the equipment manually
Check operation of motors, controls and lights

The checking of each station should be recorded and any malfunction of the equipment should be noted and work orders issued for its repair. If the repair work can be carried out by municipal forces, it should be done immediately, but if outside forces are required, they should be obtained as soon as possible.

Many pumping stations have overflows discharging to watercourses, therefore in the case of complete pumping station breakdown every effort must be expended to prevent the overflow from entering the watercourse for extended periods of time. If sewage

does enter a watercourse steps must be taken to reduce the septic nature of the flow (i.e., chlorination, removal of solids, etc.) and to report it to the Ministry of the Environment.

Manhole Inspection

Due to isolated partial blockages of the sewers caused by rags etc., or by sticks dropped through manhole vent holes, partial collapse of sewer, root problems, etc., it is necessary to check the sewer oftener than actual cleaning operations are required. A Manhole Inspection Crew, therefore, should check all manholes once a year for the following:

Debris in manhole

Depth of sewage in pipes

Indications of partial blockages

Indications of damage to manhole or pipes due to industrial wastes

Missing, broken or dangerous manhole steps

Manhole covers in need of maintenance work

Condition of benching

Where possible, any remedial action should be taken by the manhole inspection crew. However, many problems are beyond their ability to remove and must be reported to the sewer cleaning division for immediate action.

Sewer Cleaning

The frequency of sewer cleaning should be established on the basis of need. Some sewers must be cleaned, at the very least, once a year, others can be left for longer periods but in any case

every sanitary sewer should be cleaned at least every three to five years.

Grease and root infiltration are probably the most difficult problems facing sewer maintenance crews at the present time. When problem areas are found, they should be recorded preferably on a map and then assigned to crews who will be responsible for ensuring that each area is visited at least once a year.

Grease is not easily removed by jet flushing, especially where heavy concentrations are encountered. Therefore, it is recommended that bucket machines be used in this operation. The bucket removing as much grease as possible, then the remainder being removed by the use of porcupine brushes.

Jet flushers or sewer balls can be used in areas of light grease problems, sand and gravel infiltration and general cleaning. Sewer rodders should be used in conjunction with bucket machines for placing night cables and for the removal of blockages in case of emergencies.

A bucket machine can clean between 20 and 30 miles of sewer in a year and a sewer jet cleaner can clean from 60 to 70 miles of sewer per year depending on how long they can work. Bucket machines and rodders each require a three man crew and jet flushers and sewer balls require two men. Therefore the number of machines and men required will depend on the number of miles of sewer you wish to clean in a year.

Sewer Inspection by Camera

Sewers should be inspected by camera when the following conditions exist:

(1) When a problem is known to exist in a sewer but the cause and location cannot be determined.

(2) Whenever sewer back-up occurs, the sewer should be

inspected by camera to ensure there is no physical problem in the line.

(3) Older systems should be inspected to ensure their condition is not deteriorating.

(4) New systems prior to assumption.

The first two items are on an 'as required' basis, while the third should be a systematic inspection of all sewers that have been in operation for more than twenty years.

The results of these inspections should be used in determining what remedial maintenance work should be carried out and what replacements should be made.

Sewer gauging should be carried out in conjunction with any inspections due to flooding and back-up, to ensure that the flow in the sewer is not reaching capacity during normal periods.

Gauging can also be used when information is required as to how older systems are operating and if additional area can be added to them.

Industrial Waste Control

Periodic preventative maintenance testing for deleterious industrial wastes should be carried out at every industrial plant from time to time. How often a plant should be checked depends on the operation being carried out. For example, electro plating and food processing plants should be checked more often than operations which are completely dry and only discharge sanitary wastes to the sewer. Service stations and shopping centres should be checked on a regular basis to ensure that grease traps and oil

interceptors are being properly maintained. How often these systems should be cleaned depends on how much material is being discharged through them. Traps and interceptors should never be allowed to fill up as when they are full they cease to operate efficiently.

Manholes should be installed at the property line on all industrial services. The installation and maintenance costs of these manholes should be borne by the industry. All testing and checking of effluent is made through these manholes.

When deleterious material is found, a report should be submitted with a copy to the offending industry with instructions on how to remedy the situation. It should be pointed out that industries are responsible for the quality of all material being discharged and it is up to them to install any pre-treatment facilities to ensure that any effluent they discharge is within the limits prescribed by the by-law.

When an industrial effluent is checked and found to be within the prescribed limits of the by-law, it should not be construed as a carte blanche approval of all effluents being discharged by that plant, but only an approval of those being discharged at the time of the test.

Private Property Inspections

Due to the increased use of basements, increased tendency of architects to set house elevations too low in order to achieve a "ground hugging" aesthetic appearance, increased incidence of poor lot grading, discharge of roof water close to buildings, etc., the problem of roof water and surface runoff reaching the sanitary sewers

has reached such proportions that the sanitary sewerage system is required to accommodate flow quantities in excess of design with consequent over loading of the sanitary sewers.

Preventative maintenance consists of periodic check of each and every house and lot within a specific area which is tributary to a particular trunk, sub-trunk or major sanitary sewer.

If Manhole Inspection or other Inspection, or cleaning operations, indicates that the flow in the sanitary sewer appears to be increasing considerably during periods of rainfall, each building and lot within the tributary area is inspected for the following:

(a) Illegally connected roofwater downspouts
(b) Illegally connected cellar or window areaways
(c) Illegally connected surface water catchbasin
(d) Poor lot grading and evidence of surface water entering the building or the sanitary sewerage system.
(e) Roof water discharge in such a manner that it will probably reach the sanitary sewers.

When any of these are found, steps should be taken to have them corrected.

When storm connections have been made to sanitary sewers, it is also likely that sanitary connections have been made to storm sewers. When this possibility exists, all plumbing fixtures in an area should be dye tested to ensure they are connected to the proper sewer.

SEWER CONNECTION MAINTENANCE

How sewer connections are maintained depends on each individual municipality. There are many avenues open in this matter.

The municipality can respond to all calls for assistance regardless of where the blockage is. In some cases, charges are made to the property owner when the blockage is found to be on the private location.

Some municipalities will respond only when the blockage is on the municipalities side of the connection. The property owners must prove that their portion of the connection is clear at their own expense, before the municipality will send anyone to check the municipal portion.

Other municipalities feel that as the connection really belongs to the property owner, they are responsible for all blockages that occur in it, regardless of its location.

Whichever method or variation of method is used, a record should be kept of blockages on the municipal side of the connection, and if a number of blockages occur at the same location, the connection should be dug up and any faults in it repaired.

WEIRS IN COMBINED SEWERS

Many communities still have combined sewer systems and although most of the foregoing applies to both seperate and combined sewers there are certain problems which are unique to combined sewers. One of these is the use of weirs to control flow during storms. These weirs must be checked to ensure they are at the proper height and that they are free of debris.

In the appendix there is a copy of a Weir Inspection Report used by the City of Toronto Public Works Department which might be of assistance to anyone setting up a weir inspection program.

MANPOWER

Larger sewage systems do require full-time staff; how many depends on the size of the system and how comprehensive a maintenance

program is set up. Bucket machines, rodders, wayne balls or flushers should be purchased if the system warrants it. The number of men required depends on the number of machines available, as follows:

Bucket Machines	3 men per set
Rodders	3 men per unit
Wayne Balls	2 men per unit
Flushers	2 men per unit
Service Rodding Crews	3 men per crew
Pollution Crews	2 men per crew

These men can be used for other activities when their sewer cleaning duties cannot be carried out, such as snow removal in winter and extra hands for picking up garbage after long weekends etc.

sewer by-laws

SECTION 6

SEWER BY-LAWS

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SECTION 6

SEWER BY-LAWS

The scope, content and format of sewer by-laws varies widely across the Province and it is the intent of this section to discuss only the main topics included in these by-laws. The topics can be reviewed under the following headings: -

1) Connections

2) Plumbing

3) Sewer Use

1. Connections

The sections of sewer by-laws dealing with connections set out regulations for their construction and maintenance generally on the right-of-way. (The remaining portion of the connection on the private sector is covered under Plumbing but some provisions under Connections relate to the private sector as well). The regulations for Connections are very diverse and frequently only pertinent to a particular municipality and only the following points of general interest will be reviewed: -

(a) Construction

A typical requirement is that of Scarborough which states as follows: -

> "No sewer connection shall be constructed on any road allowance or other public land, except by the Borough or under a contract with the Borough. Any contract work done for the Borough shall be under such performance and maintenance guarantees and liability insurance provisions as shall be required by the Commissioner and the work shall be subject to the supervision and inspection by the Commissioner and all Municipal by-laws and regulations."

The Scarborough by-law also authorizes the Commissioner of Works to temporarily disconnect any sewer connection if he considers it necessary.

(b) Multiple Connections

Connections serving two or more buildings are now permitted by some municipalities. The Ottawa by-law states as follows: -

> "In the case of a group building project or row housing where the units in the group building project or row housing do not abut on a street and the land upon which the group building project or row housing is to be erected is subject to part lot control and all the land being developed as a group building project or row housing is in one ownership, then one sanitary and one storm sewer connection may be permitted for each block of the group building project or for each row or section of units of row housing."

The Hamilton by-law states as follows: -

"(a) Where land is used for residential purposes, not more than,

(i) one single family or two family or three family dwelling or multiple dwelling, or

(ii) one dwelling of a pair of semi-detached dwellings, or

(iii) one lot or parcel or building or premises,

shall be connected into one yard sewer or into one private drain connection.

(b) Notwithstanding clause (a) all dwellings within a row of attached dwellings may be connected into one private drain connection if the dwellings comply with the following conditions:

(i) each dwelling has its own separate building drain connected to a common yard sewer, and

(ii) all dwellings remain in the same ownership.

(c) Where land is used for non-residential purposes, not more than,

(i) one lot or dwelling, or

(ii) one lot under different ownership,

shall be connected into one yard sewer or into one private drain connection connecting more than one lot."

The main problem for municipal officials in the matter of joint connections is the difficulty in assigning responsibility for blockage. In the case of single connections, the blockage can only come from one property but in the case of joint connections, there is usually no indication or proof as to which property originated the material causing the blockage.

(c) Maintenance

This clause usually sets out the conditions for assigning responsiblity for repair, maintenance and clearing or blockages in the connection either solely on the street right-of-way or for the whole length from the street sewer to the building. By-law requirements under this heading are widely diversified and the following are only examples of the type of wording that is used:

Scarborough: -

" Maintenance

The Owner of land is responsible for the cost of repair, maintenance and clearing of all drains leading to a public sewer and the owner of such lands is also responsible for the cost of clearing the public sewer connection to his drains where the blockage of the sewer connection, in the opinion of the Commissioner of Works is due to the usage of the sewer connection by the land owner; provided, however, that where the Commissioner of Works, after an opportunity for inspection of the sewer connection is due to structural defect or root

penetration and is, therefore, the responsibility of the Municipality, a reasonable allowance may be paid to the land owner in reimbursement for costs which he may have incurred in investigating the blockage."

North York: -

" Maintenance Charges

Prior to the excavation of an existing corporation sewer connection by the corporation at the request of a private owner the owner shall deposit the sum of $100.00 with the Borough against which shall be charged the cost of any work required to clear the connection. If the blockage is proved to be the responsibility of the Municipality, the $100.00 deposit will be refunded."

Sault Ste. Marie: -

" Maintenance and Repair

(a) The owner of a building shall be responsible for the maintenance and repair costs for the lateral drain connection between the building and the street line. The owner shall also be responsible for blockages caused by objects placed in the sewer by occupants or users of the building for the full length of the lateral drain connection including the portion within the City road allowance.

(b) Except for blockages described above, the City will be responsible for maintenance and repair costs for the portions of lateral drain connections within road allowances. The Corporation assumes no liability for damages or inconveniences caused by failure of lateral drain connections.

(c) Every lateral drain connection shall be equipped with a readily accessible cleanout as required in Regulation 471 respecting plumbing before the Corporation will undertake any repairs."

(d) Mandatory Connection

Municipalities had no direct power prior to 1973 to compel property owners to connect to sewers, but in the latter year, Provincial legislation was enacted which permits municipalities to pass by-laws to require connection within a certain period.

(e) Improper Connections

The discharge of storm flow to sanitary sewers (or sanitary flow to storm sewers) is usually prohibited under Sewer Use provisions but some by-laws also specifically prohibit connection of sources of surface runoff to sanitary sewers. The Sault Ste. Marie by-law states as follows: -

" Surface Water Drain Connections to Sanitary Sewers Prohibited

(a) No person shall make connection of roof downspouts, exterior foundation drains, areaway drains or other sources of surface runoff or ground water to a lateral drain connection building drain which in turn is connected directly or indirectly to a public sanitary sewer.

(b) No person shall drain a basement excavation into a sanitary sewer."

2. Plumbing

The subject of plumbing generally comprises all regulations and requirements relating to all fittings, pipes and appurtenances required to convey water into a building and subsequently to remove the used water (i.e. sewage) and is usually covered in a separate plumbing by-law or in an omnibus by-law dealing with sewers and drains. Regardless of the by-law format, the total municipal requirement usually comprises Ontario Regulation 647 (as amended to 1972 by O. R. 344/71 and 209/72) respecting Plumbing, together with administrative regulations relating to the particular municipality such as permit fees to be charged, orders, notices and penalties for non-compliance.

3. Sewer Use

The Ministry of the Environment, in consultation with municipalities, has produced a sewer-use by-law guide. Most municipalities in Ontario have enacted a by-law based on this guide.

The intent of the by-law is to regulate the individual discharges to the municipal sewers to protect the sewer system and the sewage treatment plant from physical damage, and to prevent impairment or interference with treatment processes. Discharges to storm sewers are regulated in order to safeguard the watercourse receiving the storm sewer effluent.

The scope of the by-law also includes the control of the discharge of all toxic elements and any fluids which are, or can potentially become, hazardous to persons, domestic animals, wildlife or property. Hydraulic loading limitations and surcharges for excess biodegradable wastes can be imposed by the municipality.

Penalties are provided for anyone in default of the by-law and authority is provided for a municipal officer to enter buildings or lands to inspect, measure and sample all sewage.

A copy of the sewer-use by-law guide may be obtained from any regional office of the Ministry of the Environment.

appendix A

sewer law case histories

APPENDIX "A"

SEWER LAW CASE HISTORIES

The following are brief case histories of five lawsuits between individuals and municipal corporations. These are presented in order to provide non-legal personnel using this manual with a general idea as to the type of litigation that can arise from the maintenance of sewers and drains. It should be noted that the cases cited are of a common law nature and relate to circumstances where the sewer or drain involved was not constructed under the Local Improvement Act. If it was so constructed then other legal considerations, particularly those involving certain obligations on the municipality for repair, apply. In any event, the cases given are for interest only and persons using this manual should of course consult their own legal representatives on particular problems.

1. McConkey et al v. The Corporation of the Town of Brockville (1886), 11 O.R., p. 322.

The Plaintiff's house was drained by a private drain into the street drain. The neighbour, who also had a house drain connected with the street drain, put a grating across his private drain, which, incidentally, also obstructed the street drain, dammed back the water and sewage from the street drain backed up to the Plaintiff's private drain, into his cellar, and caused damage. As might be expected, the Chief Justice of the Common Plea's Division, Cameron, J., had no hesitation in dismissing

the Plaintiff's claim against the City and in doing so made certain observations that have become the basis of law ever since. He ruled that the moment the City compelled the use of the City sewer and imposed a rate on the land owner for the privilege of draining into it, the City assumes the obligation of keeping the drainage works in repair. However, if the decision to connect to the City sewer by a private drain is a voluntary one, then the City is not responsible for maintaining the private connection in good working order unless the City commits some positive act of misfeasance.

2. Welsh v. The Corporation of St. Catherines (1887), 13 O.R., p. 369.

There the Plaintiff owned and occupied a house which had been drained into an open ditch on a City street. The ditch served only a few properties on the street and was adequate to carry away the water that drained from the properties that it served. The City, some time later, connected this ditch with the drainage of other streets and more water was brought down the ditch than it was capable of carrying off. In a heavy rain the water flowed back onto the Plaintiff's premises. The Plaintiff's decision to drain his property into the ditch was a voluntary act on his part since there was no "Local Improvement" charge for the construction of the ditch. Citing the McConkey decision with approval, Chief Justice Cameron stated as follows:

> "To make a corporation liable for injury for the overflow of a drain I think it must be shown affirmatively that the corporation required the property owners to use the drain by connecting their

private drains thereto, and secondly that the drain or sewer has been improperly and negligently constructed or that the same has been obstructed and that the corporation has negligently omitted to remove the obstruction within a reasonable time after knowledge or notice of the obstruction has been had by the corporation."

The Court dismissed the Plaintiff's claim.

3. O'Brien et al v. Town of Collingwood (1934), O.W.N. 129.

This is the first example of a "tree roots" case in the reports of the Courts. The Plaintiff complained that the Defendant municipality was negligent in permitting a sewer to become obstructed by roots which caused a backflow from the main sewer in the street to the Plaintiff's private connection into his cellar. In the year 1922, the private connection was blocked up by tree roots which were removed and a galvanized patch was placed in the hole in the sewer through which the roots had entered. In 1927, the sewer was again blocked by roots from the same trees, but at a different place and again the roots were removed and the hole in the pipe covered by a galvanized patch.

The Judge stated that in his view the evidence was conclusive that the blockages had been caused by tree roots and it was perfectly obvious that blockages from this cause were likely to recur. It was argued for the City, citing the Welsh decision, that it was liable only for non-repair if this state arose from the City's negligence. The Court point out that the Welsh decision was concerned with a single stoppage and not a recurrent series of stoppages. The trial Judge, therefore, held the City liable.

Incidentally it should be pointed out that the Court took notice of the fact that since the decision in the Welsh case The Local Improvement Act has been enacted which made the corporation responsible for repair of the work and imposed a liability for nonfeasance.

4. Gerofsky v. Hamilton (1960), O.W.N. p. 525.

This was a case of obstruction to a catch basin in the City sewer which resulted in sewage backing up and flooding the Plaintiff's land. It is reported only to note that a Judge of the County Court was of opinion that in order to make a municipality liable, the Plaintiffs must affirmatively prove,

(i) that the sewer had become obstructed; and

(ii) that the municipality had negligently omitted to remove the obstruction within a reasonable time after notice of the obstruction came to its attention.

The Judge also made the observation that while it might have been true that the defect would have been identified if someone nad entered the catch basin and made an examination of the mortar instead of simply removing the lid and peering in, he did not believe that failure to enter the catch basin and minutely examine it was evidence of negligence.

5. Stockinger v. The Town of Cobourg (1944), O.R. p. 372.

This, again, was a tree roots case. The tree was located on City property. Private sewer connection was blocked on City property by roots from the tree. The work had not been constructed under The Local Improvement Act. The judgment was a

judgment of The Ontario Court of Appeal and represents the latest and most persuasive authority with reference to the subject.

Quoting the judgment of Cameron, J. in the McConkey case, Gillanders, J. A. stated as follows: -

> "I take the law to be that there is no obligation to keep the drain free from obstruction on the part of the owners of the soil through which it passes. He who enjoys the easement or privilege is bound to repair the drain and remove the obstruction and the owner of the soil would only be liable for some act of misfeasance. Non-feasance carries with it no responsibility."

Laidlaw, J. A., who also wrote a judgment in the case, added the following: -

> "It is necessary to consider the nature of the right possessed by the Plaintiff to lay the drain under the highway and connect it with the sewer. He was not bound to build it and was under no obligation to connect it with the sewer. He was free to dispose of waste water by whatever means he might think best. The Defendant corporation did not require him to make use of the sewer. He was entitled to do so as a privilege. His right was permissive in character. The procedure on the part of the owner desiring to connect a drain to the sewer was to apply to the corporation for a permit, which, when granted, enabled the owner to make the connection at his own expense, subject only to supervision by a representative of the corporation. The right acquired by the owner was in the nature of an easement."

Quoting the McConkey decision, Laidlaw, J. A. concluded that he who enjoys the easement or privilege is bound to repair the drain and remove the obstruction and the owner of the soil would only be liable for some act of misfeasance. Non-feasance carries with it no responsibility.

APPENDIX "B"

BOROUGH OF NORTH YORK

PROCEDURE FOR CLEAN-UP

OF LIQUID SPILLS

The above is presented as an example of a municipal clean-up procedure. It should not be used as a reference insofar as telephone numbers, addresses, etc. are concerned since these may change over the course of time.

BOROUGH OF NORTH YORK

PROCEDURE FOR CLEAN-UP

OF

LIQUID SPILLS

From time to time, accidents will occur which will allow liquids, detrimental to the environment, to be spilled. These spills will be of varying degrees of severity, depending on the material spilled, the amount and the proximity to the Municipal sewer system. Subsequent action taken will depend on these three factors.

IMMEDIATE ACTION:

It is imperative that the first person at the scene of any accident of this nature take every step necessary to prevent the spilled material from entering the storm sewer system or watercourse.

In the event of a spill occurring within the limits of the Borough of North York, the following procedures will be followed:

1. If the first notification of a spill is by telephone, the person receiving the call must obtain the following information:
   (a) the name, address and telephone number of the person reporting
   (b) the time of the call
   (c) the exact location of the spill (street, nearest cross street, and is spill on road or not)
   (d) the type of material spilled and the amount, if possible

(e) has any other agency been notified (Fire Department, Police Department, Metropolitan Toronto, O.W.R.C., etc.)

2. The above information must then be relayed to the Director of Operations, Borough of North York Public Works Department, during office hours. If after office hours, the North York dispatcher must be advised.

SPILLS ON GROUND

The Public Works Department or Public Works dispatcher will dispatch any available crew to the scene IMMEDIATELY, and notify the Police and Fire Departments, if their assistance is required. The crew will then report the severity of the situation to the Public Works Department or dispatcher who will then notify the appropriate agencies. This crew will then take all steps necessary to prevent the material from entering the sewers. To do this, they must:

(a) Build a dike, using any available material, to prevent the spill entering the sewerage system.

(b) Contain the spill in as small an area as possible.

(c) Cover the spill with an absorbent material such as sand then remove all contaminated material to an approved dump site.

(d) If any material has entered a catchbasin, it should be removed by a catchbasin cleaner.

If a spill is discovered by a North York employee during working hours, he will institute the above procedure immediately, using existing crews and then report the situation as in pargraphs #1 and #2 so that all agencies may be notified.

SPILLS ENTERING SEWERS & WATERCOURSES

If the spilled material has entered the storm sewer and is being discharged into an open watercourse, the following procedure

shall be followed:

1. Notify the Metropolitan Toronto Public Works Department, Water Pollution Control Division, at 367-8234, during Office hours, and 367-8211 after hours, and request that a Stickoar Oil Boom be provided.
2. The oil boom shall be placed across the watercourse at the closest point downstream from the outfall discharging the spilled material, so that all that has entered the watercourse shall be prevented from going further downstream.
3. Assist the Metropolitan Toronto Public Works Department crews in all ways possible to contain the spill and remove the contaminants from the watercourse.

If Metro's crews are not available, a boom shall be obtained from them and placed, as stated above. Once the material is contained it shall be removed from the surface of the water, either by hand or mechanically skimming, whichever is required.

All liquid removed from the surface shall be placed in a tank which will separate the contaminants from the water. The water treated in this way shall then be passed through a bed of Sorbant 'C', so that any remaining contaminants will be removed, and then returned to the watercourse, upstream from the boom. The contaminant remaining in the tank will then be removed to an approved dump site.

NOTIFICATION OF APPROPRIATE AGENCIES

Spills will be classified as minor, moderate or major, depending upon the volume of the spill, the nature of the material spilled, and the effect of the spill on the environment. Subsequent action taken will depend upon these three classifications.

(a) Minor Spills

If the spill is of a minor nature, the Borough of North York Public Works Department crew will contain and clean up the spill as previously noted. The Metropolitan Toronto Public Works Department, Water Pollution Control Division must be notified of the spill to avoid any duplication of the clean-up efforts.

(b) Moderate Spills

If the spill is of a moderate nature, the North York Puolic Works Department will notify the Metropolitan Toronto Public Works Department who, along with the North York crew, will commence the clean-up operation. If the North York crew is the first crew at the scene, they must try to contain the spill, employing measures set out earlier, until the Metro Works crew arrives with the appropriate equipment.

In the case of both minor and moderate spills, the Ontario Ministry of the Environment must be notified as soon as possible, at 965-6346, during working hours. Any Company involved in the spill must also be notified and must aid in the clean-up operation or give any pertinent details about the spilled material. The Fire and Police Departments will be notified, as required.

(c) Major Spills

If the spill is of a major nature, the North York Puolic Works Department will notify the Ontario Ministry of the Environment Operations Centre, at 965-2537 (24 hours per day) and the Metropolitan Toronto Public Works Department, at 367-8234, during Office hours, and 367-8211 after hours.

The North York crew will provide any assistance required by the Ministry of the Environment. If the North York crew is the first at the scene, they must, as noted before, try to contain the spill and prevent the material from entering the sewers, until the other crews arrive.

AGENCIES TO BE NOTIFIED AND THEIR FUNCTIONS

1. Borough of North York - Public Works Department

   This Department must be notified of all spills within the boundaries of the Borough of North York.

2. Metropolitan Toronto Public Works Department - Water Pollution Control Division

   This Department must be notified of all spills, as layed out earlier in the procedures.

3. Province of Ontario - Ministry of the Environment

   965-6346 (working hours)
   965-2537 (Operations Centre - 24 hours)

   This Department must be notified of all minor or moderate spills during working hours. Major spills must be reported Immediately to the Operations Centre.

4. Metropolitan Toronto and Region Conservation Authority

   This agency must be notified of all spills

5. Metro Toronto Department of Emergency Services

   This agency co-ordinates all emergency operations in Metropolitan Toronto. They have direct lines to all other agencies and can provide useful information in an emergency situation. They operate a 24 hour switchboard.

6. Borough of North York Fire Department

   The Fire Department must be notified if a flamable or explosive condition exists.

7. Ontario Provincial Police

   This Department must be notified if a major Highway is involved (e.g. Highway #401).

8. Metropolitan Toronto Police Department

The Police Department must be notified if a road allowance is involved or if there is any danger to public safety.

9. Cyanamid Company Limited

(416) 356-8310

This is a number set up by the chemical industry to supply information about unknown chemicals and possible methods of treatment to render them harmless.

10. Toronto Finch Avenue Co-Operative

661-1010

In the event of a major petroleum spill where the assistance of the industry is required this co-operative will dispatch a mobile clean up unit to the scene upon request.

METROPOLITAN TORONTO WORKS DEPARTMENT
WATER POLLUTION CONTROL DIVISION
OIL SPILL CONTROL EQUIPMENT

ROCKCLIFFE YARD

North of St. Clair Avenue West, east of Rockcliffe Blvd.

Booms purchased from Industrial Plastics Canada Ltd.

1 - Mark VI Stickbar Oil Boom with hitch connectors.
100 foot total length for use on larger bodies of water.

15 - Pieces Mark VI Stickbar Oil Boom in 12 foot attachable sections, with 6" floats and 6" skirts.

2 - 10" diameter mooring buoys

2 - Galvanized anchors

Other Equipment:

6 - Hand skimmers with 1/8" mesh screen.
Screen hoop attached to handles for individual use

2 - Rigid Manta Ray Skimmer heads for mechanical skimming.
For use with mechanical pumps

30 - 22" x 40" disposable polyurethane oil absorbent pillows. For use as booms on smaller watercourses

20 - 18 lb. bags of "Sorbant C" oil absorbing materials

15 - 30 lb. bags of "Slickwik" oil absorbing materials

Bales of straw

PHARMACY YARD

East side of Pharmacy Avenue, 1st road north of Prairie Dr.

20 - 22" x 40" disposable polyurethane oil absorbent pillows.
For use as booms on smaller watercourses

10 - 18 lb. bags of "Sorbant C" oil absorbing materials

Bales of straw

APPENDIX "C"

REPORT FORMS

The keeping of records of work carried out by Maintenance Crews is most important. From these records you will be able to rate your maintenance program with respect to how often sewers in certain areas should be cleaned, what is being discharged into the system and what changes are required in the system. How each Municipality collects the necessary information and what they do with it is a matter of their own choice. However, the use of various types of forms is probably the easiest way of relaying this information from the field to the office.

The use of forms and the writing of reports in the field should be controlled. A form of any type should be used only where necessary and the form itself should be as simple as possible. On the following pages, there are a number of forms which are used by the Borough of North York. It is not suggested that these are the best there are, but they have been found useful by this Municipality, and variations of them may be found useful by others.

INDEX

NO.	DESCRIPTION
1.	Weir Inspection
2.	Pollution Control
3.	Pollution Complaint
4.	Daily Pollution Control Summary
5.	Blockages in Main Sewers
6.	Visual Inspection of Sewers
7.	Mechanical Cleaning of sewers
8.	Pre-Cabling of Sewers for Cleaning
9.	Flushing of Sewers
10.	Blockages in Sewer
11.	Preventive Maintenance of Sewers

DEPARTMENT OF PUBLIC WORKS
OPERATIONS SECTION

WEIR INSPECTION

Date_____

Rainfall in last 24 hours Heavy_____
Light_____
Nil _____

WEIR NUMBER	TIME OF INSPECTION	PHYSICAL CONDITION OF WEIR STRUCTURE	OVERFLOWING? If Yes: Length of Overflow	OVERFLOWING? If Yes: Depth of Overflow	OVERFLOWING? If No: Free Board	Remarks (Debris Removed, etc.)

Handyman_____
Foreman _____

125

Superintendent_____

126

BOROUGH OF NORTH YORK
DEPARTMENT OF PUBLIC WORKS

POLLUTION CONTROL REPORT

DATE: _____

INVESTIGATED BY: _____

TRUCK NUMBER: _____

REASON FOR INVESTIGATION: _____

_____

POLLUTION LOCATION: _____
(Address)

POLLUTING AGENT: _____
(Gasoline, Oil, Sewage, etc.)

SOURCE OF POLLUTING AGENT: _____

ACTION TAKEN: _____
(Testing)

IF CROSS CONNECTION:

WAS PLUMBING DEPARTMENT INVOLVED IN INSPECTION? _____

CROSSED AT STREET LINE: Yes_____ No_____

	CONNECTED PROPERLY	CROSS CONNECTED
SINKS	_____	_____
TOILETS	_____	_____
BATHTUBS	_____	_____
FLOOR DRAINS	_____	_____
ROOF DRAINS	_____	_____
OTHER	_____	_____

ANY FOLLOW-UP ACTION NEEDED: _____

_____

COMMENTS: _____

_____

_____

_____

SIGNED: _____

BOROUGH OF NORTH YORK - WORKS DEPT.

POLLUTION COMPLAINT RECORD DATE.....

POLLUTION LOCATION: (Outfall, Creek, Ravine, etc.)

.....

DESCRIPTION OF POLLUTION AGENT: (Gas, Oil, Dye, etc.)

.....

NOTIFICATION RECEIVED FROM: (Private Party, Metro Conservation, Ontario Water Resources, Metro Pollution, Borough Representative)

Name.....Address.....Phone No.....

ORIGINAL INVESTIGATION BY: Name.....District Foreman
Stand-by
Sewer Cleaning
Foreman

Work Order Number:.....

Report:.....

.....

.....

.....

.....

.....

FOLLOW-UP ACTION NEEDED BY:.....
(Private Party, Metro Conservation, Ontario Water Resources, Metro Pollution, Borough)

Remedial Action Taken: (Detail)

.....

.....

.....

.....

.....

BY:.....DATE:.....

SIGNATURE:.....DATE:.....

BOROUGH OF NORTH YORK
DEPARTMENT OF PUBLIC WORKS

DAILY POLLUTION CONTROL SUMMARY SHEET

DATE: _____

NAME: _____

AREA CHECKED: _____

TYPE OF CHECKING: _____
(Dye Testing, Screens)

RESULTS: _____

FOLLOW-UP ACTION NEEDED: _____

_____

SIGNED: _____

BOROUGH OF NORTH YORK
PUBLIC WORKS DEPARTMENT

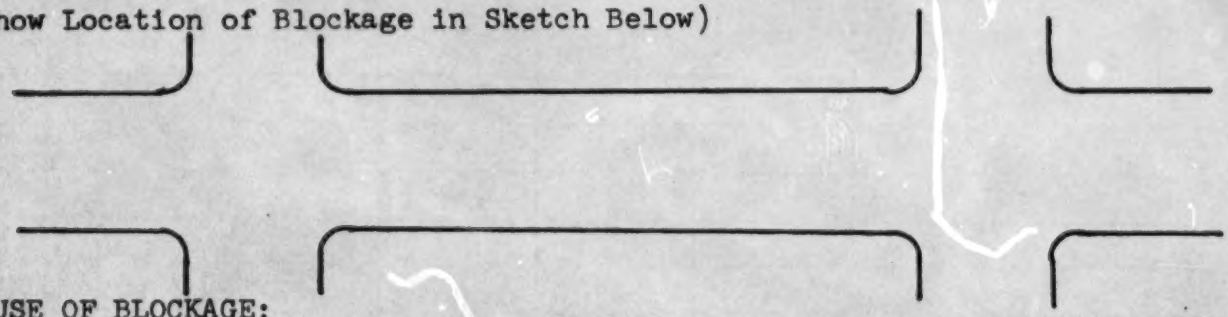
BLOCKAGES IN MAIN SEWERS

DATE: _____ ,19___
WEATHER: _____
TEMPERATURE: _____

LOCATION -
STREET NAME: _____
HOUSE NO.s AFFECTED: _____
NEAREST CROSS STREET: _____

TIME CALLED OUT: _____ A.M. _____ P.M. TIME STARTED: _____ A.M. _____ P.M.
CALLED OUT BY: _____ TRUCK NO. CALLED: _____
DRIVER: _____ CREW: _____

TYPE OF SEWER: STORM _____ SANITARY _____
LOCATION OF BLOCKAGE: IN LINE _____ IN MANHOLE _____
(Show Location of Blockage in Sketch Below)



CAUSE OF BLOCKAGE: _____

PREVIOUS CALLS: _____
DATE SEWER WAS LAST MACHINE CLEANED: _____
DATE OF LAST VISUAL INSPECTION: _____
LAST INSPECTED BY: _____
CONDITION OF SEWER WHEN LAST INSPECTED: _____
COMMENTS: _____

_____
FOREMAN'S SIGNATURE

BOROUGH OF NORTH YORK
PUBLIC WORKS DEPARTMENT

VISUAL INSPECTION OF SEWERS

COLOUR SCHEME - Pink

STORM Up To & Including 27"	STORM 30" & Over	SANITARY	STREET	FROM	TO	DIRECTION OF FLOW	REMARKS	ASSESSMENT SHEET #

PERIOD ENDING _____ FOREMAN _____

BOROUGH OF NORTH YORK
PUBLIC WORKS DEPARTMENT

MECHANICAL CLEANING OF SEWERS

Truck Number..... Week Ending.....

ASSES. SHEET #	NAME OF STREET	(To next intersecting) STREET STREET	LENGTH OF STRETCH	DIRECTION OF FLOW	REMARKS OF CONDITION

Noted on Plan.....Foreman.....

BOROUGH OF NOFTH YORK
PUBLIC WORKS DEPARTMENT

PRE-CABLING OF SEWERS FOR CLEANING

Rodding Machine #.....Operator.....W/E Date.....

STREET	FROM	TO	DISTANCE IN FEET	NUMBER OF STRETCHES	CONDITION	ASSES SHEET#

Noted on Plan.... ..... Foreman.....
#80

BOROUGH OF NORTH YORK
PUBLIC WORKS DEPARTMENT

FLUSHING OF SEWERS

COLOUR SCHEME - Lavender

SANITARY	STORM	STREET	FROM	TO	REMARKS	ASSESS-MENT SHEET #

PERIOD ENDING _____ FOREMAN _____

BOROUGH OF NORTH YORK
PUBLIC WORKS DEPARTMENT

BLOCKAGES IN SEWER

COLOUR SCHEME - Black

SANITARY	STORM	STREET	INTERSECTION OR HOUSE NUMBER	HOUSE NUMBERS AFFECTED	CAUSE OF BLOCKAGE & REMEDIAL ACTION TAKEN	ASSESS-MENT SHEET #

WEEK ENDING _____ FOREMAN _____

BOROUGH OF NORTH YORK
PUBLIC WORKS DEPARTMENT

PREVENTIVE MAINTENANCE OF SEWERS

TRUCK NO. _____ OPERATOR _____ WEEK ENDING DATE _____

STREET	FROM	TO	DISTANCE IN FEET	NUMBER OF STRETCHES	CONDITION	ASSESS-MENT SHEET #